2000

Gambling behaviour and the distribution of alcohol consumption model.

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GAMBLING BEHAVIOUR AND THE DISTRIBUTION

OF ALCOHOL CONSUMPTION MODEL

By

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MA University of Windsor 1995

A Dissertation

Submitted to the Faculty of Graduate Studies and Research

Through the Department of Psychology in Partial

Fulfillment of the Requirements for the

Degree of Doctor of Philosophy at

the University of Windsor

Windsor, Ontario Canada

2000

0-612-62319-X

Abstract

The parallels between gambling and other addictive behaviours, such as alcohol abuse and alcohol dependence, suggest that theoretical and empirical work derived from the study of alcohol consumption may be useful in understanding aspects of gambling behaviour. One approach to understanding drinking behaviour in a population is the distribution of consumption model first proposed by S. Ledermann in 1956 and significantly extended by O.-J. Skog. This "distribution of consumption model" suggests that alcohol consumption in a population will be highly skewed to the right, i.e., toward higher consumption levels, be characterized by the lognormal distribution, and that the shape of this distribution is due to the multiplicative combination of contributing factors. Social interactions in the population are considered to be a primary contributing factor. The distribution of consumption model has been used to link increases in alcohol availability to increased average consumption, the increase in average consumption to increases in heavy consumption (as predicted by the distribution of consumption model), and increases in heavy consumption to increases in alcohol related problems. The present study has tested the applicability of the distribution of consumption model to the five year study of gambling in the City of Windsor, Ontario. Strong support has been found for the applicability of the distribution of consumption model to gambling consumption. The implications of the distribution of consumption model as it applies to gambling are discussed.

Acknowledgments

I would like to thank my wife Ewa for her support, which made this endeavor possible. I would like to thank Dr. G. R. Frisch, my supervisor and colleague in the Problem Gambling Research Group for his guidance and support. I would like to thank Dr. Robert Mann, Social, Prevention and Health Policy Research, Centre for Addictions and Mental Health (Toronto), for first introducing me to the work of Sully Lederman and for his encouragement and support throughout this research project. Finally I would like to thank my committee members, Ron Frisch (chairperson), Michael Kral, Robert Whitehurst and Bill Balance for their advice, encouragement and assistance.

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Introduction

Background

In the early post World War II era Canadian laws and societal attitudes limited and confined legal gambling to horse racing and charity bingo. A new era was ushered in 1969 when the Federal Government changed the Criminal Code of Canada to allow government operated lotteries. Although the initial lottery was federally operated by Loto-Canada, the Provinces and Territories lobbied the Federal Government for the right to operate provincial lotteries and the Federal Government agreed to transfer control of the lotteries to the Provinces and Territories in return for a share of the revenue. This transfer of power paved the way for the rapid expansion of gambling at the provincial level (National Council of Welfare, 1996).

By the late 1990's gambling had become pervasive in Canadian society. The Provinces and Territories operate an extensive array of lotteries, from instant win tickets to sports betting. The gross sales of lottery tickets in Canada is estimated to have been approximately $5.2 billion in 1994/1995. The Provinces and Territories allow, as support for charities, the operation of a variety of modes of charitable gaming, such as bingo, casino nights and raffles. These are estimated to have had sales of close to $5 billion in 1994/1995. Horse racing or pari-mutual betting is estimated to have gross sales of $1.9 billion in Canada in 1994/1995, and is concentrated primarily in Ontario. A number of permanent casinos have been established in Canada, three of which are in Ontario, Casino Windsor located in Windsor across from Detroit Michigan, Casino Niagara located in Niagara Falls and Casino Rama located on First Nations land north of Toronto. Video Lottery Terminals or VLTs have been established in most

Provinces of Canada. VLTs are essentially slot machines and represent an extension of the casino into the general community. The Ontario Government is currently considering the introduction of up to 20,000 VLTs into this Province. Although reporting inconsistencies make it difficult to estimate the overall casino and VLT wagering it has been estimated at approximately $8 billion per annum in 1994/1995 (National Council of Welfare, 1996).

Gambling has become a significant source of revenue for the Provinces and Territories. The 1995 national gambling revenue total of $4.6 billion represents 2.7% of the revenues of the Provinces and Territories. In the Province of Ontario gambling revenues are 2.8% of total provincial revenue (National Council of Welfare, 1996).

The dramatic growth of gambling in Canada was paralleled in other jurisdictions, such as the United States of America, Europe, Australia and New Zealand. Levels of gambling-related problems have also been increasing over this period. Prevalence studies from the period 1977 to 1993 have shown an average prevalence in the previous year of 0.84% for problem gambling behaviours that would qualify for a diagnosis of pathological gambling. For prevalence studies in the period 1994 to 1997 the average prevalence level had risen to 1.29% (Shaffer, Hall, & Vander Bilt, 1997). This increase in problem gambling resulted in the formal inclusion of pathological gambling as a psychiatric disorder in the Diagnostic and Statistical Manual of Mental Disorders, III (American Psychiatric Association, 1980), and spurred interest both in the provision of treatment for problem gambling and in research into problem gambling. Not surprisingly, one of the first areas of research to gain attention was the measurement of the levels of problem gambling in the population. Governments that promoted the rapid expansion of gambling generally had not undertaken a systematic study of its impact on society, leaving researchers to take up the task of estimating the societal impact of gambling. Other areas of research that developed focused on the causes and treatment of problem gambling behaviour. Early research in modeling gambling behaviour tended to be narrowly focused and did not produce comprehensive models of gambling behaviour or pathological gambling (Blume, 1987). Recent research has seen the development of general addiction models by gambling researchers (Jacobs, 1993; Shaffer, 1996). The lack of a psychoactive substance in gambling, has focused research on the broad social and psychological aspects of addictions. As a result, in a relatively short time gambling research has begun to make significant contributions to the general field of addictions (Brown, 1993). These models also have shifted the focus from one based on pathology to one based on gambling behavour in general.

Although gambling research has begun to incorporate social, psychological, and biological factors into general models of addiction, little work has been carried out on understanding the relative importance of these factors either to gambling behaviour in general or to problem gambling. An understanding of how gambling behaviour is influenced by these factors would be of interest not only to theoreticians, but also to clinicians as a guide to developing treatment programs, and to policy makers who make decisions on how to regulate the gambling industry. Although gambling issues and research are relatively recent, alcohol use has been a long standing public policy issue and has a much longer research history. Models of alcohol consumption have been developed to describe and to offer explanations for the distribution of alcohol consumption throughout the general population and for the more extreme cases of alcohol abusers. One such model, the distribution of consumption model (often called the single distribution model) was first suggested by Ledermann (1956). This model has been influential in the field of public health policy on alcohol (Bruun et al., 1975; Edwards et al., 1994), and offers a theoretical model of how consumption patterns are established in a population.

This dissertation will first look at the approaches developed to date to describe and explain gambling behaviour, second, review the distribution of consumption model for alcohol, and third, propose a program of research to determine the applicability of the distribution of consumption model to gambling behaviour.

Review of Gambling Research

Definition of Pathological Gambling

The current definition of pathological gambling, which is used for diagnostic purposes, is contained in the DSM IV (American Psychiatric Association, 1994). The DSM-IV classifies pathological gambling as an impulse control disorder. The main features of impulse control disorders are: (a) a failure to resist an impulse, (b) increased tension or arousal before committing the act, and (c) the act is ego-syntonic, that is, pathological gambling is conceptualized as a progressive failure to resist gambling impulses. This failure is considered chronic and believed to result in increased disruptions to various aspects of the gambler's life. The main diagnostic criteria for the disorder are:

a) preoccupation with gambling,

b) need to increase amounts of money spent on gambling,

c) unsuccessful attempts to control gambling,

d) withdrawal symptoms,

e) gambling as a means of escape from problems,

g) attempts to recoup losses by gambling,

h) lying to others to conceal gambling activities,

i) commission of illegal acts to support gambling,

j) risked or lost relationships, jobs or career opportunities, and

k) reliance on others for financial relief of gambling problems.

A person exhibiting five or more of the above behaviours is considered a pathological gambler. Although pathological gambling is classified separately from other forms of addiction in the DSM-IV, such as substance dependence disorder, the basic diagnostic criteria for these disorders are almost identical, with the exception of the additional criterion of attempting to recoup losses through gambling. Not only are the characteristic features of compulsive gambling almost identical to those of substance abuse but there are also high levels of comorbidity between substance abuse and pathological gambling. For example, a recent study of clients attending substance abuse facilities in Windsor Ontario, (Rupcich, Frisch, & Govoni, 1997) found that the co-morbidity of probable pathological gambling was approximately 14.3%. This is approximately 10 times the prevalence rate of pathological gambling in the general Windsor adult population. High comorbidity rates suggest that gambling and substance abuse may have a shared etiology. A direct study of the relationship between gambling and impulsivity has challenged the placement of gambling in the impulse control disorders (Langewisch & Frisch, 1998). This study surveyed university students using measures of problem gambling and impulsivity, and found a relationship between gambling behaviour in the general student sample and measures of impulsivity, but no relationship between measures of impulsivity and probable pathological gambling. The similarities between gambling and substance abuse behaviour, the high comorbidity, and the uncertain link between impulsivity and problem gambling behaviours suggest that the disorder of pathological gambling may be misplaced among the impulse control disorders and that it may be better placed among the other addictive disorders.

Another aspect of the DSM-IV conceptualization of pathological gambling is the concept of pathological gambling as a chronic degenerative disorder (American Psychiatric Association, 1994). This approach is typical of the medical or disease model. This model is also the basis of the Gamblers Anonymous program. The literature does not support the concept of inevitable progressivity of gambling disorders (Blaszcynski, McConaghy & Franknova, 1991; Dickerson, 1987; Rosencrance, 1985-1986). Nevertheless, the medical model has proven to be useful in identifying and diagnosing the disorder of pathological gambling (Blume, 1987), and in doing so opens the possibility that in the long term a similar range of treatment options and facilities that are available to substance abusers will also become available to gamblers. In summary, the DSM-IV provides diagnostic criteria for pathological gambling that is virtually identical to the criteria for substance abuse but provides a different conceptualization for pathological gambling, viewing it as an impulse control disorder, distinct from the addictive behaviours which are viewed as the product of psychoactive substances.

Models of Gambling Behaviour

A variety of approaches has been taken by researchers to provide a framework to understand gambling behaviour in general and problem gambling in particular. Each of these approaches will be reviewed in the following sections.

Rational or economic approach. An alternate view of gambling, perhaps inspired by the financial aspects of gambling, is to view the gambler as a rational person who makes gambling decisions based on the utility of the expected outcomes. Eadington (1987) has taken an economic approach to gambling and views gamblers as consumers who are considered to be self-interested, goal-oriented and rational. Their behaviour is governed by two motives: the achievement of high levels of wealth, and the utility derived from actual participation in gambling activities, including entertainment and social interactions. Given this view, economic principles can then be used to model gambling behaviour. For example, if people gamble primarily for wealth creation then the poor will spend a larger fraction of their wealth on gambling activities than will the rich. Also, if people gamble primarily for entertainment, games perceived highest in entertainment value, such as casino games, should predominate over less entertaining games, such as lotteries. Cummings and Corney (1987) also assume that gamblers are rational. They have applied Fishbein's (1979) theory of reasoned action and assume that gamblers make rational decisions based on analysis of available information. In this approach a gambler's decisions are based on behavioural intentions, attitudes and subjective norms for the behaviour. The behavioural intentions are the result of the gambler's attitudes and subjective norms, and demographic and socio-economic factors influence behaviour by influencing attitudes and subjective norms. Although economic based studies have shown some ability to describe general gambling behaviour, this approach has considerable difficulties explaining why excess gambling behaviour exists despite the severe and continued financial losses and other negative consequences. Continuing such behaviours is hardly a rational process. The assumption of rationality is further called into question by the study of the cognition of problem gamblers. As we shall see in the next section on cognitive approaches to problem gambling, cognitive distortions are an important aspect of problem gambling. Such an approach is consistent with the interpretation of Fishbien's theory in terms of subjective logic in which an individual's behaviour is logically consistent with internal beliefs and expectation, even though these beliefs may be considered irrational.

Cognitive approach. Although the economic approach assumes that a gambler is basically rational, there is considerable evidence in the literature that gamblers frequently display evidence of irrational thinking, i.e., illusions of control, superstitious thinking, and cognitive distortions about chance outcomes (Brown, 1993). Using the method of thinking aloud, Ladouceur (1993) found that more than 80% of gambling related verbalizations were irrational, i.e. did not conform to the laws of probability. In a study of slot machine players, Griffiths (1993), using the thinking aloud method, found irrational verbalizations and illusions of control over the slot machines in regular gamblers. It is hypothesized that such irrational cognition helps to initiate and maintain problem gambling behaviour.

Individual characteristics approach. A variety of attempts has been made to identify the characteristics of gamblers. Gender has often been considered a characteristic that influences the amount and type of gambling behaviour, with males being the predominant gamblers (Lindgren, Youngs Jr., McDonnald, Klenow, & Schriner, 1987). Recent prevalence studies show a relatively small difference in participation levels between males and females. In Washington state 51% of all gamblers were female and 55% of weekly gamblers were male (Volberg, 1993b), and in Texas, 55% of all gamblers were male (Wallish, 1993). Women are considered more likely to gamble on games such as bingo and raffles, and men on games such as blackjack and lotteries. In the Ontario prevalence study (Canadian Foundation on Compulsive Gambling, 1993), 29% of women and 10% of men reported playing bingo, while 19% of men and 10% of women played blackjack or casino games. These differences in gambling behaviour are often attributed to gender role socialization. Lindgren et al. (1987) surveyed 1,964 residents of North Dakota to determine if attitude differences towards gambling between males and females were consistent with gender role socialization. They found only limited support for this hypothesis, and attribute their findings to a reduction in the differences in male and female roles and to a greater acceptance of gambling that has resulted from increased legalization and social acceptance.

Some researchers have attempted to develop profiles of the characteristics of the typical gambler. Martinez-Pina et al. (1991) compared 57 casino pathological gamblers to 114 controls matched on sex and age. They found pathological gamblers compared to controls had lower family stability, lower work stability, more psychiatric illnesses, poorer health, and were more likely to be poly-addicted to alcohol and drugs. Intelligence, as measured by the Weschler Adult Intelligence Scale (Revised) (WAIS-R), was lower in pathological gamblers. McCormic and Taber (1987), in their literature review, propose the following salient personality dimensions as characterizing the pathological gambler: obsessive-compulsive, negative affect (depression, hypomania and anxiety), trauma and life stressors, and poor socialization (egotistical, narcissistic, lacking in empathy, and poly-addicted). In contrast, Peck (1986), in his literature review, lists the following personality characteristics to be commonly found in pathological gamblers: above average intelligence, industrious and successful workers, high energy, athletic ability, and good school performance. They are also characterized by seeking challenge, stimulation, and tolerating boredom poorly. Such contrasting views of gamblers suggest that they do not represent a homogeneous group. In a review of the gambling literature, Murray (1993) has concluded that no single psychological test has demonstrated consistent differences between gamblers and non-gamblers.

It has also been suggested that demographic characteristics, such as education, income, marital status, religion and occupational status, can characterize gamblers (Sommers, 1988). However, when demographic characteristics are analyzed statistically most of them do not significantly differentiate gamblers and non-gamblers (Nova Scotia Department of Health, 1993; Volberg & Steadman, 1992).

Social factors approach. Sociologically based gambling researchers challenge the medical or disease model of gambling. The DSM-IV conceptualization is considered to be based on gamblers who are in treatment and trying to quit, as opposed to typical gamblers in the general population, or problem gamblers who have reduced or stopped gambling. This position is supported by prevalence studies, such as that of Volberg and Steadman (1989) who demonstrated that Gamblers Anonymous members are significantly different from pathological gamblers in the general population. Observations of gamblers in natural gambling settings suggest that most problem gamblers, i.e., those who lose excessive amounts of money, maintain equilibrium rather than experience an inexorable downward progression of problem gambling behaviour (Rosecrance, 1985-86). The sociological approach emphasizes environmental factors, rather than disease, as important causal factors in pathological gambling. Ocean and Smith (1993), in their analysis of casino gambling, see the casino as representing Goffman's (1967) total institution which satisfies three main spheres of life: dwelling, playing, and working. The casino, by offering a complete environment in which gamblers can develop a network of friends, experience the excitement of gambling and the illusion of financial gain, creates a situation in which gamblers can develop a sense of achievement and obtain social status. These factors provide sources of self esteem and reinforce and maintain the gambling behaviour. Social constructionists extend the sociological approach to cultural values and belief systems which define the roles of an activity, such as gambling in a society. Abt and McGurrin (1992) suggest that gambling is a symbolic ritual that represents the chance and risky events that naturally occur in our world and allows us to experience, in a safe manner, the risks of life, its losses, and, for a time at least, successes. In this way we learn to deal with risks in a socially controlled manner. The pathological gambler, from this perspective, is actually incurring real risks and is not playing according to the cultural rules and values.

Physiological factors approach. Gamblers have been consistently shown to report higher childhood attention deficit hyperactivity disorder (ADHD)-like symptoms than controls. For example, Rugle and Melamed (1993) compared 33 non-substance abusing pathological gamblers to 33 non-addicted controls on attention measures and a questionnaire on childhood behaviours. Gamblers showed attention deficits in executive functions, such as concept formation, and also reported more childhood behaviours indicative of ADHD. The authors concluded that the results show that gamblers have long term attention deficits and that such deficits place individuals at risk for addictive disorders. Subtle EEG differences, similar to those in ADHD patients, are also found in gamblers (Carlton & Manowitz, 1987; 1992). Unlike alcoholics, who also have high levels of reported ADHD-like behaviour in childhood, gamblers do not consistently show lower levels of behavioural restraint. Instead, gamblers fall into two categories: either less controlled as compared to alcoholics, or over controlled as compared to a normal control group (Carlton & Manowitz, 1992). These results suggest that gamblers may have an abnormal hypo or hyper active resting state.

Relatively few studies of neurotransmitter levels in gamblers have been made. Roy et al. (1988) studied 24 pathological gamblers for indicators of neurotransmitter deficits. No evidence was found for low levels of 5-HT in cerebral spinal fluid (CSF) despite the fact that the disorder is conceptualized as an impulse control disorder and has an extremely high suicide rate, both of which are associated with low CFS levels of 5-HT. However, low CFS levels of 3-methoxy-4-hydroxyphenylglycol (MHPG) and high urinary levels of norepinephrine were found, suggesting a deficit in the noradrenergic system. This finding is consistent with the conceptualization of gambling as a sensation seeking activity.

<u>General Addiction Models.</u> Gambling has also been viewed as an activity that allows the gambler to modify an internal state. England and Götestam (1991) suggest that gamblers may well gamble to lift their mood (79% of gamblers entering treatment reported that they gambled to forget their troubles). McCormic (1987) has also proposed a model in which gamblers gamble because of chronic under-stimulation or depression. A more comprehensive model has been proposed by Jacobs (1986) who has proposed a general theory of addictions. In this approach addiction is considered a subjective state that is acquired to relieve a dysphoric condition. Two factors predispose an individual to becoming addicted: an abnormal resting state, either depressed or excited; and childhood experiences that produce a sense of inadequacy, and the use of fantasy as a defense mechanism. In a predisposed individual addiction, is triggered by a chance encounter with an activity that relieves the abnormal resting state. In Jacob's approach the relief from the

dysphoric state takes the form of dissociative behaviour. Dissociative behaviour includes experiences such as memory blackouts, losing track of time and feeling like a different person. Jacobs (1993) in a survey of over 400 gamblers and alcoholics and over 1000 controls found strong support for high levels of dissociative experiences for gamblers and alcoholics when gambling or drinking as compared to controls. Carlton and Manowits' (1992) demonstration of over- and under-controlled groups of gamblers supports the over- and under-controlled aspect of the model proposed by Jacobs.

Shaffer (1996) has extended Jacob's (1986) general addiction model. Examining addictions to psychoactive substances, gambling and the internet, Shaffer concludes that it is the ability of an activity to cause a shift in subjective experience that makes it potentially addictive. Psychoactive substances produce this shift by direct action on the brain's neurochemistry and other activities, such as gambling, indirectly affect the brain's neurochemical system. The fact that not all gamblers or users of psychoactive substances become addicted suggests that a range of factors, e.g. biological, psychological and social, must come together to produce addictive behaviour. As Shaffer notes, it is not yet clear how these factors combine to produce addictive behaviour. Since the neurochemical change is of itself not sufficient to produce an addiction, Shaffer considers the psychological set of person, the setting in which the activity is undertaken and the nature of the activity itself, e.g. the type of gambling activity to be crucial in establishing the subjective experience of the activity.

Summary. Gambling as an addiction has presented a challenge to researchers. On the one hand it has almost all the features of traditional substance based addictions and on the other hand lacks the obvious psychoactive substance which can act directly on the central nervous system.

This seeming paradox has caused researchers and theorists to seek common mechanisms that underlie addictive behaviour. A recognition that what is sought by the addict is an altered subjective state and that this state can be achieved either through psychoactive substances or through psychological means, e.g., gambling activities. It is also clear that psychoactive substances or activities such as gambling are in themselves not sufficient to cause an addiction and that biological, psychological and social risk factors combine to produce an individual's susceptibility to addictive behaviour.

Gambling Prevalence Studies

As attention was turned to problem gambling it was important to establish just how prevalent problem gambling was in the general population. A number of surveys have been carried out that provide a picture of problem gambling in North America, many European countries, Australia and New Zealand. Additional questions of how are gambling activity and problem gambling levels being influenced by increasing levels of gambling availability and what public policy measures, if any, can be employed to limit the levels of problem gambling are just beginning to be addressed.

Survey instruments. The survey instrument that has been used most widely in gambling prevalence studies is the South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987). The screen was developed, in three stages, at the South Oaks Hospital in Amityville, New York, a private psychiatric hospital that provided treatment for alcohol and other drug dependencies and a treatment program for pathological gamblers. In the first two stages questions based on the DSM-III diagnostic criteria were developed, and the ability of these questions to discriminate between patients diagnosed as pathological gamblers and non-gambling patients was examined.

Twenty questions were selected for the final screen and a score of five or more was selected as indicative of probable pathological gambling. These two developmental stages involved a total of 655 patients. The index was cross-validated, in the third stage, on 213 Gamblers Anonymous members, 384 college students and 152 hospital employees. A cutoff score of five or more on the 20 item screen correctly classified 98% of the Gamblers Anonymous members, identified as pathological gamblers 5% of the college students and 1.3% of the hospital employees. The reliability of the screen was measured in two ways. First, a measure of internal consistency was calculated. A value of 0.97 for Cronbach's alpha showed the test to be very reliable. Second, the test was readministered 30 days later. The test-retest correlation was an acceptable 0.71.

Although the SOGS screen has good indicators of validity and reliability based on the populations studied, Lesieur and Blume (1987) note that the true sensitivity and specificity within the general population remains unknown, and that differences in prevalence rates may result in different true and false positive and negative rates.

The SOGS screen has been adapted in a number of ways in various prevalence studies. Lesieur and Blume (1993) have reviewed the various modifications and provide suggestions as to their suitability. The authors suggest that the initial questions, which ask about the type of gambling that subjects participate in, be modified to suit the gambling practices of the jurisdiction where the screen is being used. Such changes help the subjects define the concept of gambling before proceeding to the remainder of the screen. The original SOGS screen is based on lifetime gambling activity and does not differentiate pathological gamblers in remission from active pathological gamblers. The authors suggest that the SOGS may be modified to cover a six month or one year time frame to identify active pathological gamblers. The SOGS screen has not been validated for a one year or six month time frame and the results for a six month or one year time frame can be considered as suggestive only.

Culleton (1989) has proposed a Cumulative Clinical Signs Method (CCSM) as an alternate to the SOGS screen. This approach is based on the Inventory of Gambling Behavior (IGB) which reflects the criteria of the DSM-III for pathological gambling. The items on the IGB were reduced in stages to twenty items that discriminate pathological gamblers from groups of inpatient alcohol and drug abusers at the South Oaks Hospital. The items were then tested on Gamblers Anonymous members, hospital workers, and students. The predictive value of the test was 98.5% for the Gamblers Anonymous members, 80% for the students, and 50% for the hospital workers. The declining predictive values over the various groups are attributed to a declining prevalence rate that influences the ability of a test to predict the presence or absence of a disease. Culleton (1989) applied the CCSM methodology to estimate the prevalence rate of gambling in the Delaware Valley and Ohio. The prevalence rates were 3.4% probable pathological gamblers and an additional 4.1% potential pathological gamblers in the Delaware Valley, and 2.5% probable pathological gamblers and 3.4% additional potential gamblers in Ohio. In comparing the CCSM to the SOGS, Culleton points out that the application of a screen to estimate the prevalence of a disease is a reversal of the standard epidemiological approach and he applies this criticism to the New York prevalence study (Volberg & Steadman, 1988) that was based on the SOGS screen. Despite this criticism, the methodology used in developing the CCSM test is virtually identical to that used in the development of the SOGS. Culleton criticizes prevalence studies based on the SOGS screen for failing to compensate for false positive misclassifications. He also suggests that the odds ratio methodology of the CCSM provides a method of predicting errors that is independent of the prevalence rate. The odds ratio is the probability of correctly identifying pathological gambling when pathological gambling is present divided by the probability of incorrectly identifying pathological gambling when pathological gambling is not present.

Volberg and Banks (1990) have compared the CCSM and SOGS measures of pathological gambling. They point out that both the CCSM and SOGS were developed in the same manner and that the SOGS sensitivity and specificity is very high. As a result the SOGS results require very little adjustment of estimated prevalence rates. Volberg and Banks also point out two flaws in Culleton's (1989) odds ratio approach to predicting errors. First, although the odds ratio itself is independent of the prevalence rate, the predicted number of errors is dependent on the prevalence rate. Second, the assumption of statistical independence of the test items, on which the odds ratios are calculated, is not valid for the CCSM items. They also point out that the SOGS has been selected as the best available method by a wide variety of researchers and has become the de facto standard for gambling prevalence measurement.

Despite its wide acceptance in prevalence studies the SOGS has received significant criticism. The use of the screen has been criticized, because the instrument has only been validated in a clinical population and not in the general population (Ferris, Wynne, & Single, 1998). Recent work Stinchfield (1998) has compared the SOGS to DSM based criteria. The SOGS was found to generate a significant number of false positives and to potentially over estimate levels of problem gambling by approximately 50%. Stinchfield attributes this, at least in part, to the subjective self report nature of the screen. The SOGS has also been criticized for placing a much greater emphasis on financial problems than the DSM criteria (Ferris et al., 1998; Stinchfield, 1998)

The widespread acceptance of the SOGS has also led to the acceptance of the three levels into which the screen categorizes gamblers: non-problem gambling, problem gambling and pathological gambling. Shaffer and Hall (1996) have proposed an extension of these three levels. They suggest the addition of two additional categories, a non-gambling category and a pathological gambler who is willing to enter treatment category. Such a classification system has the potential of conveying a wider range of information about the gambling in a population.

Another screen used by approximately 50% of clinicians (Rosenthal, 1989) is the Gamblers Anonymous 20 questions (GA-20). The 20 items in the instrument address behaviors related to compulsive gambling, for example, remorse over gambling, gambling to forget problems, borrowing money to gamble, etc. Although the GA-20 is commonly used, there is little psychometric and classification accuracy information available. Ursua and Uribelarrea (1998) note that there are no published reports describing the development of the GA-20 and only two studies that report any psychometric information. In terms of validity, Kuley and Jacobs (1988) report that the GA-20 yielded high correlations with frequency of gambling and with dissociative experiences. One study conducted in Spain specifically examined the psychometric properties of the GA-20. Ursua and Uribelarrea (1998) conducted a study of the psychometric properties of the GA-20. They found that the internal consistency of the GA-20, using Cronbach's coefficient alpha was .94 and that the GA-20 was highly correlated with the SOGS (r=.94).

The National Opinion Research Center (NORC) has recently developed a DSM-IV based Screen for Gambling Problems (NODS) and employed this screen in a national problem gambling survey for the National Gambling Impact Study Commission (National Opinion Research Center, 1999). Little is known of the psychometric properties of this DSM-IV based instrument (Personal correspondence Dr. Randy Stinchfield, September, 2000). The authors report reasonable psychometric properties however the test sample consisted of approximately 40 individuals in treatment for gambling related problems. The national survey based on the NODS produced estimates of problem and pathological gambling (in the previous year) that were approximately one tenth of the typical values fund in previous prevalence studies.

Review of Prevalence Studies In Canada eight provincial studies carried out between 1989 and 1996 provide a reasonable picture of the current levels of problem gambling in Canada (National Council of Welfare, 1996). The results are shown in Table 1. Shaeffer, Hall and Bilt (1997) have conducted a meta-analysis of 120 problem gambling prevalence studies carried out in North America during the two decades, 1977 to 1997. Recent prevalence studies, (from 1994 to 1997), showed that, in the previous year, approximately 1.29% of the adult population was estimated to have had levels of problem gambling that would qualify for a diagnosis of pathological gambling. This level of estimated pathological gambling in North America is consistent with the recent estimated of pathological gambling provided by the various Canadian prevalence studies. Although Canadian studies are relatively recent and do not give any insight into changes in problem gambling levels over time, the Shaffer, Hall and Bilt (1997) meta-analysis does show increasing levels of problem gambling with time. For example, earlier prevalence studies, 1977 to 1993, show that approximately 0.84% of the adult population was estimated to qualify for a diagnosis of pathological gambling in the previous year. Given the overall similarity in prevalence rates between the United States and Canada it is reasonable to assume that similar increases took place in Canada as gambling activities were introduced to this country.

Table 1

Reported Gambling and Problem Gambling in Canada

	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia
% Who gamble	97	93	88	92	52	55	80	96
% Lifetime problem gamblers	6	5.9	2.8	N/A[2]	N/A	2.6	4	-
% Lifetime pathological Gamblers	1.8	2.7	1.2	N/A	N/A	1.2	2	-
% Total lifetime problems	7.8	8.6	4	N/A	N/A	3.8	6	5.5
% Current problem gamblers	2.4	4	1.9	2.4	N/A	N/A	3.1	2.8
% Current pathological gamblers	1.1	1.4	0.8	1.9	0.9	N/A	1.4	1.1
% Total current problems	3.5	5.4	2.7	4.3	N/A	N/A	4.5	3.9

[1] Excludes only those who have never gambled

[2] Not Available

Conclusions from Gambling Prevalence Studies

Current estimated levels of problem and pathological gambling in Canada range from 2.7% to 5.4% with 4% as an average value (National Council of Welfare, 1996). Thus gambling has in a relatively short time reached problem levels that are comparable with major psychiatric disorders.

The lower levels of current gambling problems, as compared to lifetime gambling problems, suggest that gambling is not an inexorably progressive disorder, and that a significant number of individuals are able to resolve their gambling problems on their own. Gambling treatment programs have only very recently become available and reach only a small fraction of the problem gamblers in an area. Given the limited availability of treatment programs, natural self change and/or self-help programs such as gamblers anonymous would appear to be the primary means by which individuals cope with their gambling problems. The stages of change model developed by Prochaska (Prochaska & DiClemente, 1986) has provided a model of such self-change behaviour. Recent studies have shown that self-change is an important aspect of recovery from alcohol problems (Sobell, Sobell, & Toneatto, 1992; Sobell, Sobell, Toneatto, & Leo, 1993) and the survey data suggests that it may also play a role in the recovery from gambling related problems.

Models of Alcohol Consumption

Introduction

Alcohol consumption is treated as a major public health issue because of the many negative effects. A public health approach to alcohol seeks to minimize the physical, mental and social problems resulting from alcohol consumption with formal government regulations, e.g. the minimum legal age for consumption of alcohol, and by influencing societal values and norms. Key elements on which public health policies are based are theoretical models that describe alcohol consumption in a population (Bruun et al., 1975; Edwards et al., 1994). To develop public health policies on gambling will require sound and comprehensive models of gambling consumption and gambling behaviour. The similarities between gambling and alcohol behaviours suggest that much can be learned from the more extensive research that has been carried out on general alcohol consumption and on alcohol abuse and dependence.

There have been three broad theoretical models that describe the patterns of alcohol consumption in a population: the alcoholism model, the sociocultural model and the distribution of consumption model (Rabow & Watts, 1981). The alcoholism model has concentrated on identifying factors that distinguish a sub-group of vulnerable individuals (the alcoholics) from the rest of society. The sociocultural model has concentrated on different norms and patterns of alcohol use and abuse in various social or cultural groups and focuses primarily on norm differences as the basis for different patterns of consumption in these groups. Studies within the sociocultural tradition have often focussed on ethnic or religious norms as the basis for the differing patterns of alcohol consumption found in population sub-groups. The distribution of consumption model is a statistical model of consumption of alcohol in a population. This approach has often focussed on the relationship between the average level of consumption in a population and the proportion of heavy drinkers and the attendant problems of heavy drinking, such as cirrhosis of the liver. These approaches often have produced different recommendations on how to deal with excessive alcohol consumption. The alcoholism model focussed on the treatment of vulnerable individuals who had become alcoholics. The socio-cultural model focusses on changing the norms of drinking behaviour by promoting responsible drinking as a part of every day life and discouraging excessive consumption. The distribution of consumption model has produced recommendations for the overall reduction of alcohol consumption in a population. Since it is assumed that there is a relationship between average consumption levels in populations and the proportion of heavy consumers, then a reduction in average consumption would be expected to produce a corresponding decrease in the proportion of heavy consumers. Although the two approaches initially began with different assumptions and a different focus, subsequent developments of the distribution of consumption model have produced a sociological interpretation of the distribution of consumption model, an interpretation which integrates the two approaches.

The Distribution of Consumption Model

The distribution of consumption model is a theoretical approach that has been developed to provide an understanding of the alcohol consumption patterns that are typically found in populations. Although the model is also referred to as the single distribution model, this term is somewhat of a misnomer, and as a result the term distribution of consumption model will be used. This model describes the strongly asymmetrical distribution of alcohol consumption in terms of underlying population dynamics. It is not only of theoretical interest but has also been very influential in the public health approach to the reduction of alcohol related problems (Bruun et al., 1975; Edwards et al., 1994).

Origins of the Distribution of Consumption Model

In 1956 Ledermann noted that the reduced availability of alcohol during the Second World War produced such a dramatic decline in alcohol-related problems, that consideration was being given to the conversion of "insane asylums" into hospitals or homes for seniors at that time. However, in the post-war period, as alcohol availability was restored, there was a progressive return of the negative effects of alcohol in the French population (Ledermann, 1956). These events provided the inspiration for an investigation into the patterns of alcohol consumption, and led to an extensive study of the production and consumption of alcohol in France and its impact on the French people.

Ledermann (1956) found that the distribution of alcohol consumption in the French population as a whole and in sub-populations was highly skewed to the right and could be described as a lognormal distribution, i.e., the distribution approached the normal distribution if the logarithm of the consumption was used instead of the consumption itself. Ledermann noted that in a population whose consumptive behaviour is described by the lognormal distribution, a small percentage of the population consume a significant proportion of the total. For example, in a population with an average consumption of 30 litres of absolute alcohol per year, those who consume the relatively high level of 20cl. of absolute alcohol per day, about 7% of individuals consume 25% of the total amount of alcohol consumed by the population. Investigating various geographic regions of France, Ledermann found that the percentage of the population that were heavy drinkers, e.g. greater than 20cl. of absolute alcohol per day or the equivalent of 12 bottles of beer increased in a non-linear manner with increased average consumption. Ledermann also found that within the sub-groups of the French population the proportion of excessive consumers varied as the square of the mean consumption of the sub-group. At that time the difference in mean consumption from the south to the north of France differed in the ratio of 1:3 while the percentage of the population consuming greater than 20cl. per day of absolute alcohol was approximately 1:10, i.e. from 3-4% to 30%.

Although Ledermann provides extensive mathematical analysis of the lognormal distribution and its application to the French data, he provided little explanation of the underlying mechanisms which produce the distribution (Ledermann, 1956). He did seem to be aware that social factors play a role when he comments that the lognormal distribution often occurs when the phenomenon under consideration develops by a mechanism of contagion or snowballing, but he develops this concept no further. In support of this contention Ledermann cites an American survey that asked individuals for reasons that would encourage their consumption of wine. The principal reasons given were "If I was reminded of it more often", "If more people around me drank", "If the other people in my family liked wine", and "If it was in the house more often". He also seems to be aware that it may be possible to modify the relationship between average consumption and proportion of heavy drinkers by efforts to inform and educate the French population and decrease the number of heavy consumers without affecting the more reasonable consumers. However Ledermann points out that the effects of such programs were unknown at that time. Indications that social factors play a role or the relationship could be shaped by education are few and far between in Ledermann's work. Instead he presents a strong mathematical case for a fixed nonlinear relationship between the average consumption and the proportion of heavy drinkers and for the conclusion that a reduction in average consumption is required to reduce alcohol related problems. This single parameter model is reinforced by several factors: first, Ledermann describes these relationships as a distribution law, the same term that one would apply to the relationships in physics or chemistry; second, an extensive mathematical analysis of the distribution is presented coupled with a mathematical demonstration of the fit of the distribution to the population data, giving the strong impression that the hypothesis is on a very strong mathematical footing; and finally, a mathematical demonstration of the non-linear relationship between the mean and the proportion of heavy drinkers is given suggesting that there is a fixed relationship between the average consumption of alcohol in a population and the proportion of heavy drinkers.

Ledermann's (1956) approach not only provided a radically new way of mathematically describing the manner in which consumption of alcohol is distributed in a population but also challenged the prevailing alcoholism model. At that time the general conception of alcoholism was that alcoholics were a distinct sub-population that was predisposed to the disease of alcoholism (Single, 1988; Skog, 1982). In the disease model approach one would have expected that the prevalence of alcoholism would be relatively independent of the overall consumption in the population (Leifman, 1996) . Ledermann's demonstration of a smooth continuous distribution with no obvious subgroup in the high consumption tail of the distribution clearly challenged the disease model of alcoholism. The apparent relationship between the mean consumption of alcohol in a population and the percentage of heavy consumers also pointed to a possible means of reducing the number of heavy consumers and thus the problems associated with alcoholism, that is, by influencing the mean levels of consumption.

An aspect of Ledermann's mathematical analysis that subsequently led to considerable criticism and confusion was his method of estimating the distribution parameters from the population (Ledermann, 1956). Ledermann recognized that there was a practical upper limit to the amount of alcohol that an individual can consume and, as a result, the distribution of consumption in a the population is truncated at this value. Ledermann assumed that a level of one liter of absolute alcohol per day would be rapidly fatal and assumed an arbitrary 1% of the population was truncated, i.e., the measured distribution represented only 99% of the theoretical distribution. These assumptions allowed Ledermann, after a series of lengthy calculations, to estimate mathematically the parameters of the lognormal distribution in his samples. Ledermann also noted that the upper limits should be estimated based on the actual population under investigation. His strictly mathematical approach reflects the computational difficulties of the times when researchers were equipped with little more than pencil and paper and a table of logarithms. Today computational power allows for curve fitting without utilizing the assumptions and methodology Ledermann required.

In summary, Ledermann's approach to describing alcohol consumption (Ledermann, 1956) is built on two main hypotheses. First, that the pattern of consumption of alcohol in a population is highly skewed and can be described mathematically by the lognormal distribution. Second, that there is a relationship between the mean consumption level and the proportion of heavy drinkers in a population, i.e., the lognormal distribution of alcohol consumption can be described by a single parameter, the mean. This second hypothesis implies that there is a relationship between the mean and variance of these distributions. Based on this approach Ledermann concluded that the principal way to reduce the proportion of heavy drinkers, and thus alcohol related problems, is by reducing overall consumption.

The Lognormal Distribution

Before proceeding with a detailed discussion of the development of the distribution of consumption model, it would be appropriate to first review, the history of the lognormal distribution, the basic properties of the lognormal distribution and the implication of finding a population described by such a distribution.

History of the Lognormal Distribution in Psychology. Although the lognormal distribution has its origins with the pioneers of psychology, it presently is almost totally neglected in this discipline. The study of the lognormal distribution was initiated by Francis Galton. Galton argued that the geometric mean,

$$\bar{g}=\sqrt[n]{(x_1 * x_2 * \ldots * x_n)} \quad ,$$

was for some populations a better descriptor than the more familiar average or mean

$$\bar{x} = \frac{(x_1 + x_2 + ... + x_n)}{n}$$

Galton drew some of his inspiration for the geometric mean and logarithmic distributions from the work of Fechner and Weber. He suggested the study of the lognormal distribution to McAlister and presented McAlister's monograph on the lognormal distribution to the Royal Society of London in 1879 (Aitchison & Brown, 1966). This development was continued by Karl Pearson, one of the most influential figures in the development of modern statistical thought and statistical processes. Although Pearson's initial papers in 1894 were concerned with the Gaussian distribution, which he named the "normal curve", in 1895 he became convinced that skewed distributions were in fact more common than the symmetrical normal curve and he developed families of "skew curves" to deal with these distributions. Although Pearson was highly influential in the development of many aspects of modern statistics, for example his work on correlation, his work on skew curves was unfortunately less successful. This is likely due to the fact that the form of the distribution was seen as less important than the fact that a wide range of distributions have sample means which are, to a reasonable approximation, normally distributed. A further reason for the decline in interest in skewed distributions was the break in the Galton-Pearson tradition by R. A. Fisher. Fisher integrated statistics with experimental design and accomplished this integration through the development of the technique of the analysis of variance. This statistical technique has become the cornerstone of statistical practice in modern psychology. Since the normality of distributions is a key assumption of the analysis of variance, the normal distribution became the key to the practice of statistics in psychology (Porter, 1986). To illustrate the pervasiveness of the normal distribution in psychology, several statistics textbooks that have been used in psychology were reviewed (Harris, 1975; Keppel, 1990; Keppel & Zedeck, 1989; Kerlinger, 1986; Kirk, 1982; Stevens, 1990; Tabachnick & Fidell, 1988). These texts had no references to skewed distributions such as the lognormal or the poisson. Where skewed distributions are mentioned at all (Kirk, 1982) they are mentioned in terms of transformations to convert them into normal distributions. Since the normal distribution is so fundamental to statistics in psychology it is not surprising that skewed distributions are treated as nuisances that are to be transformed into a normal distributions. Unfortunately, this approach fails to consider the population dynamics that produce a skewed distribution, which is quite different than the dynamic that underlies the more familiar normal distribution. These dynamics will be explored in subsequent sections.

Properties of the Lognormal Distribution. The properties and applications of the lognormal distribution have been developed by J. Atichison and J. Brown (1966) and L. Crow and K. Shimizu (1988). The following discussion of the distribution's basic properties is based on these two works. The lognormal distribution $L(\mu,\sigma)$ is defined as the distribution of a random variable whose logarithm is normally distributed with mean μ and standard deviation σ, $N(\mu,\sigma)$. The lognormal distribution is thus defined in terms of the parameters of the normal distribution that it can be transformed into. However, a lognormal distribution has a mean and standard deviation that is significantly different from the mean and standard deviation of the normal distribution it can be transformed into. Simulations have been carried to illustrate the properties of the normal and lognormal distributions, and the results of these simulations are shown in the following section. Figure 1 shows the distribution of a sample of 500 drawn randomly from a normal distribution with a mean of 5 and a standard deviation of 1.5. A similar sample of 500 drawn from a lognormal distribution with a mean of 5 and standard deviation of 1.5 is shown in Figure 2 (it should be noted that, as is conventional, the mean and standard deviation refer to parameters of the normal distribution that the lognormal distribution can be transformed into).

Because of the highly skewed nature of the distribution the extreme values are difficult to observe in Figure 2. Figure 3 shows only the tail of the distribution and reveals more fully the highly skewed nature of the distribution. If the distribution represented actual consumption of a product, then the top 10% of the sample would consume 84.9% of the total consumption, and the top 5% or would consume 51.5% of the total. Such extremes of consumption are often found in real world consumption patterns (Aitchison & Brown, 1966; Crow & Shimizu, 1988)

To demonstrate the lognormal nature of L(5,1.5), the natural logarithm of values in the distribution have been taken and plotted in Figure 4, and a quantile to quantile plot is shown in Figure 5. Clearly the transformation results in a reasonable approximation to a normal distribution.

The normal distribution has additive properties, i.e., if a constant c is added to each element of a normal distribution $N(\mu,\sigma)$ then the mean of the resulting distribution will be $\mu+c$. Since a logarithmic transformation is used to transform a lognormal distribution into a normal distribution and $\ln(x_1) + \ln(x_2) = \ln(x_1 * x_2)$, it is to be expected that the lognormal distribution will have multiplicative properties. If all the elements of $L(\mu,\sigma)$ and c is a constant, where $c>0$ then multiplying all elements of $L(\mu,\sigma)$ by c results in a distribution with a mean of $c\mu$.

Figure 1

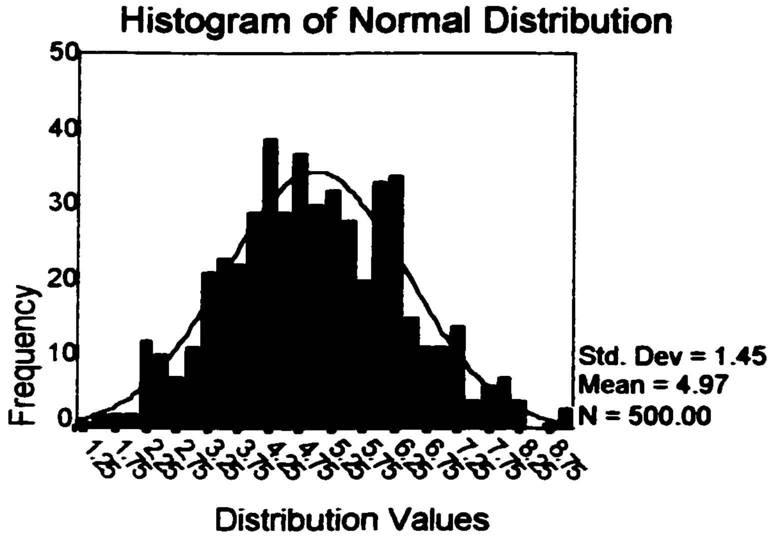


Figure 2

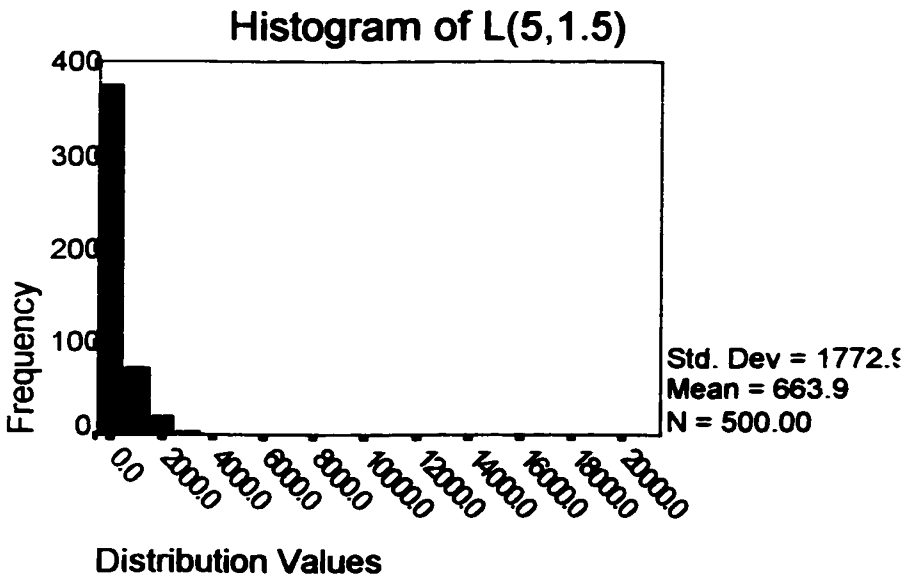


Figure 3

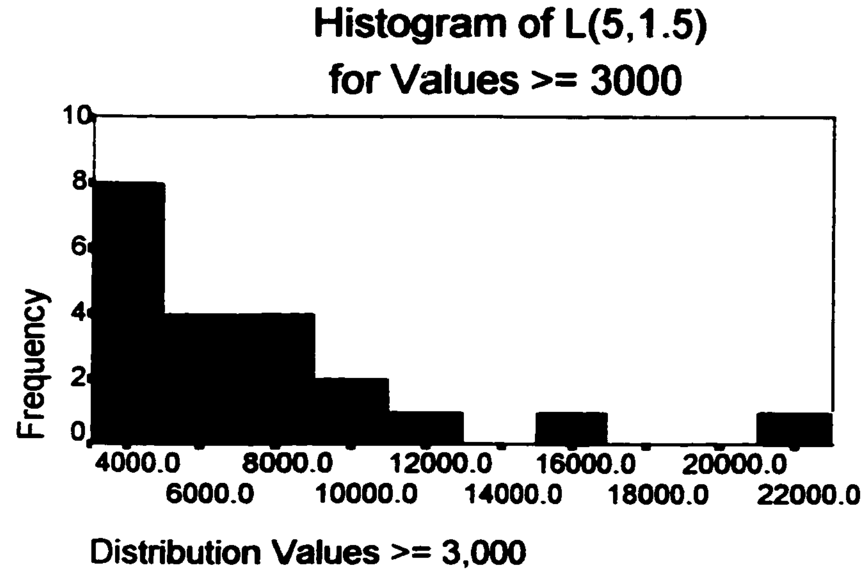


Figure 4

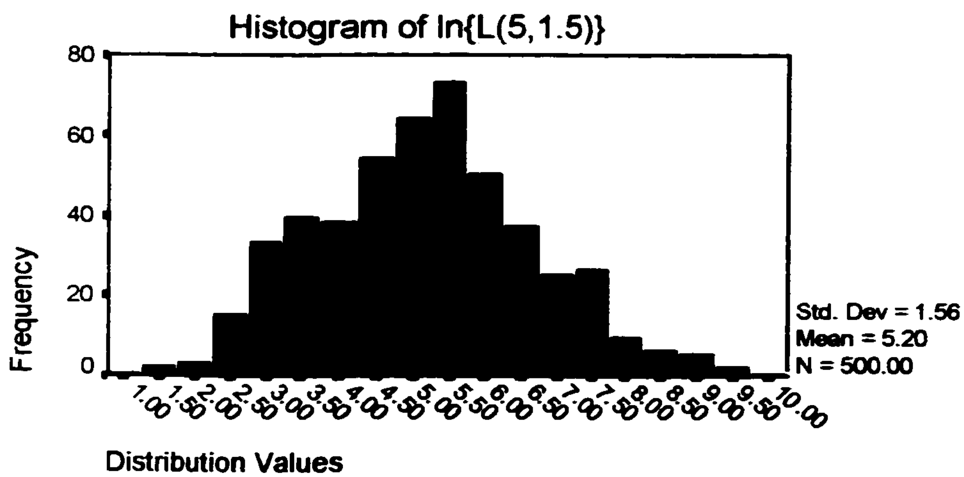
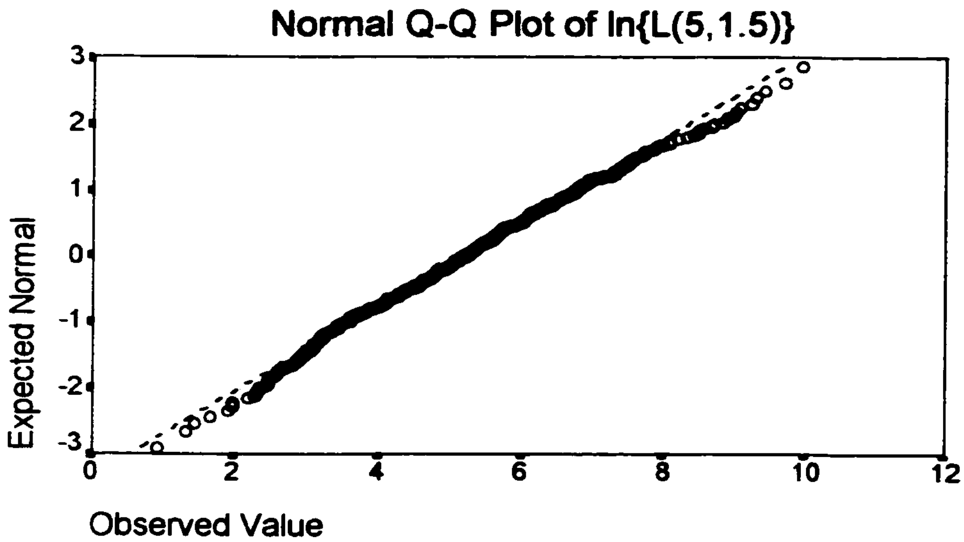
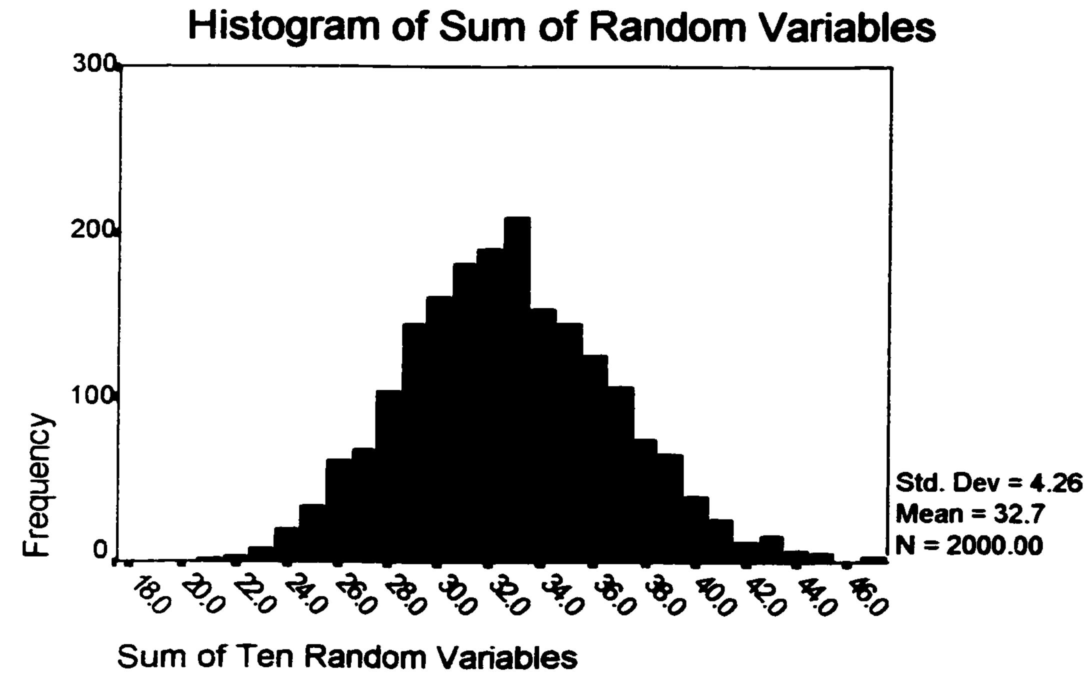


Figure 5



Origins of the Normal and Lognormal Distributions. On viewing the symmetric shape of the normal distribution and the highly skewed shape of the lognormal distribution it is clear that the populations described by these distributions must have very different underlying dynamics. The dynamics that lead to the normal distribution are described in the central limit theorem. This theorem states that if $x_1, x_2, \ldots x_n$ are random variables that meet the conditions that: a) they are independent, b) they are uniformly bounded, i.e., there exists a positive constant c such that the probability of any of the x_i having a value >c or <−c is o, and c) that the variance of $y_n = x_1 + x_2 + \ldots + x_n$ tends to infinity as $n \rightarrow \infty$, then sum of the x_i is normally distributed (Freund, 1962). Thus the presence of a normally distributed characteristic in a population, such as an individual's height, reflect the fact that the factors that contribute to an individual's height are additive. This can be illustrated by simulating such an additive process. In this simulation ten distributions were generated, five normally distributed and five lognormally distributed. The mix of normal and lognormal distributions was chosen to represent the types of distributions that might be found in real world situations. A simulated "observation" consisted of randomly selecting a value from each of these ten distributions and summing the results. Two thousand such "observations" were made in the simulation and the distribution of these "observations" is shown in Figure 6. The results are a fair approximation to a normal distribution given the modest number of individual distributions employed in the simulation.

Figure 6



The lognormal distribution of a population parameter arises when the random variables x_i that contribute to the observed population parameter combine in a multiplicative manner. To illustrate this, the previous simulation was re-run and the ten random variables for each "observation" were multiplied together rather than added as before. The resultant distribution of the 2,000 observations is shown in Figure 7. To illustrate more clearly the extreme values of the distribution the tail of the distribution is shown in Figure 8.

Figure 7

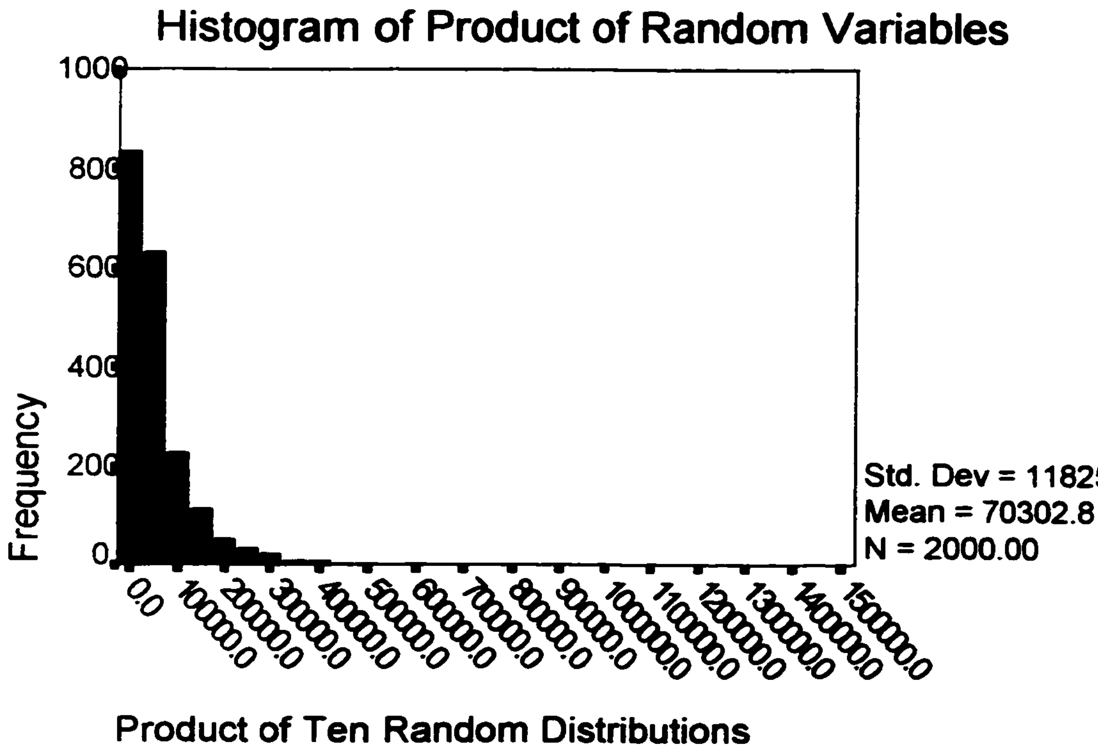
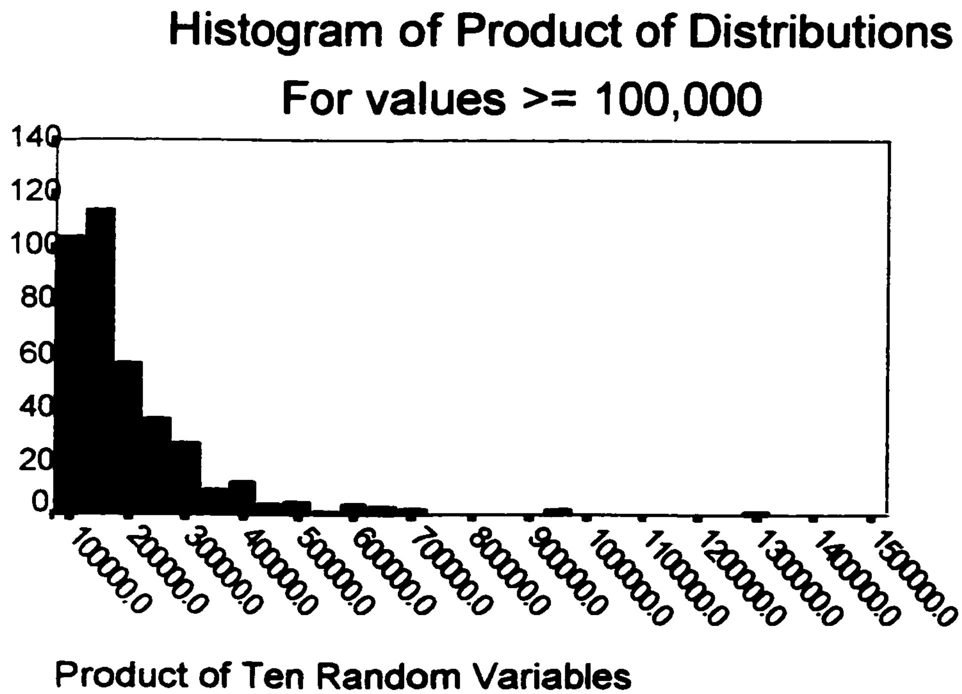


Figure 8



Clearly the distribution in this case is highly skewed to the right with the maximum value of 1,510,233 being 21.5 times the mean value of 70,303. To demonstrate that the generated skewed distribution is actually lognormal the logarithms of the 2,000 samples were taken and a histogram plotted in Figure 9 and a normal quantile plot is shown in Figure 10. Figures 9 and 10 show that the distribution resulting from the product of ten random variables is a reasonable approximation to a lognormal distribution.

Figure 9

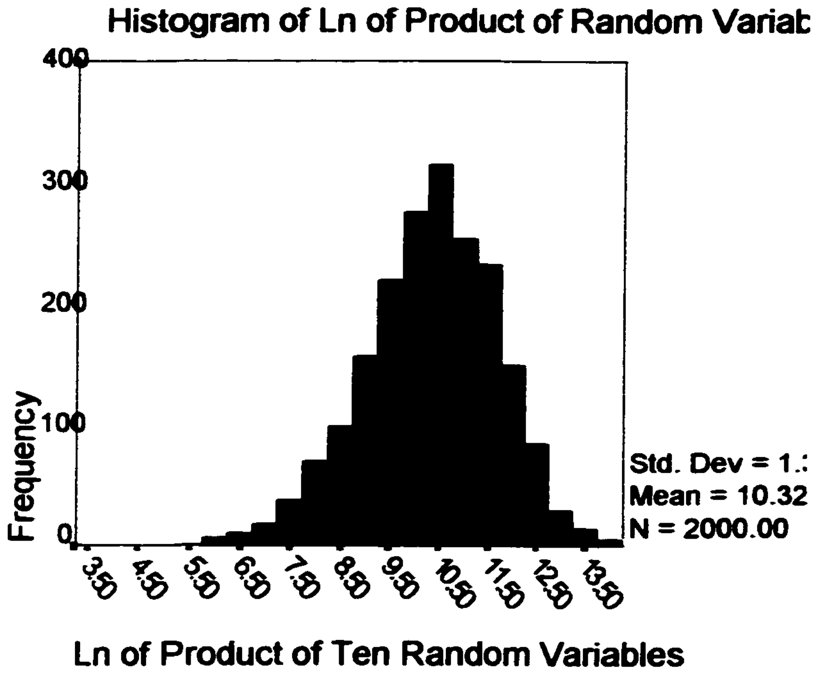
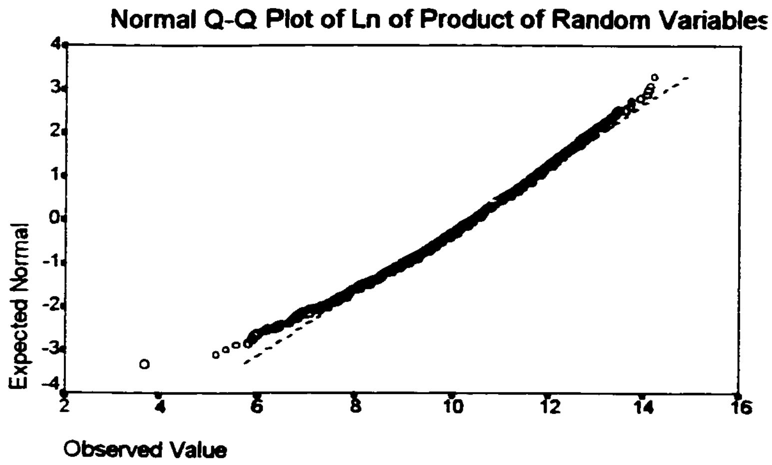


Figure 10



This simulation demonstrates the dramatically different population dynamics that underlie the normal and lognormal distribution. For the normal distribution the factors which contribute to the measured population characteristic are predominately additive in their effects on the population. In this case the resulting normal distribution shows that most individuals in such a population cluster around a central or typical value with few extreme outliers. In the case of the lognormal distribution the situation is quite different. The factors which contribute to a population characteristic are multiplicative. The resulting lognormal distribution has most individuals clustering around relatively low values of the characteristic and a small percentage of individuals with very large values of the characteristic variable.

The Change in Proportion Of Heavy Consumers. Ledermann, in his analysis, claims that the relationship between the percentage of heavy consumers and the mean consumption of alcohol in a population is a power function of the mean consumption level (Ledermann, 1956). Reading Ledermann, one might well believe that this relationship is somehow unique to the lognormal distribution. However such a relationship is a feature of distributions that have regions of rapid change in the tail of the distribution. Both the lognormal and the normal distribution have this property. The exact form of the relationship will depend on the nature of the distribution in the population. Figure 11 shows the cumulative probability of the standard normal distribution, N(0,1), and Figure 12 shows the cumulative probability of the lognormal distribution based on the standard normal distribution, L(0,1).

Figure 11

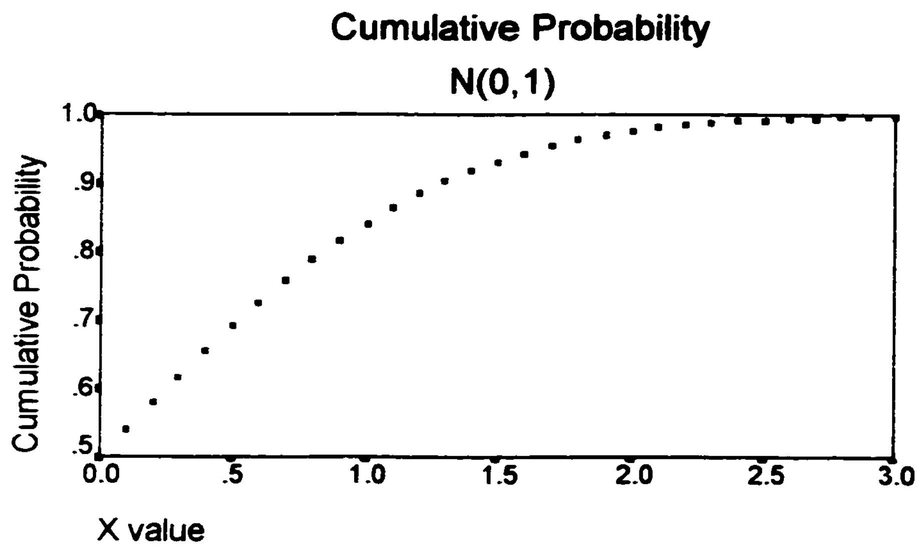
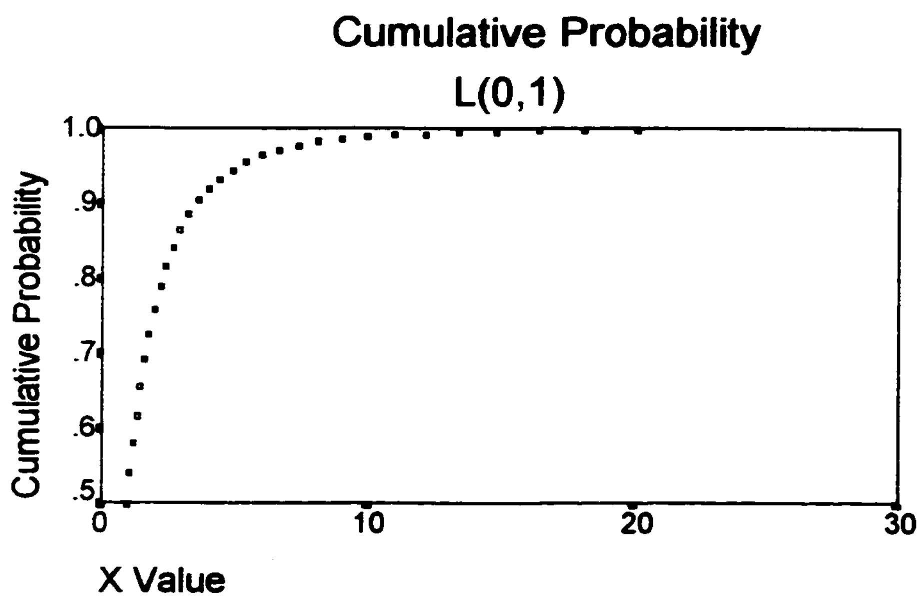


Figure 12



For convenience only the x values from 0 to 3 are shown for the normal distribution and their equivalent exponential values for the lognormal distribution. Each distribution has two relatively linear portions, the first for low values of x which represent a relatively rapid growth in cumulative probability and for higher values of x in which the cumulative probability is asymptotic to the line $y = 1$. Between these two regions there is region of rapid change. The level often set for heavy consumers of alcohol results in the proportion of heavy consumers in various populations varying from a few percent to ten percent or more. From the graphs it can be seen that these proportions lie in the region of rapid change and that when the distribution is "shifted to the right" a nonlinear relationship between the mean and the proportion of heavy consumers will result. This can be illustrated by utilizing the normal distribution and setting its parameters to N(5,5) to yield a more realistic simulation. The consumption value that defines "heavy consumption" can be set at the value that puts 2.5% of the population above this limit, a reasonable value for a low consuming population. For the normal distribution illustrated here, {N(5,5)}, this corresponds to a limit of approximately 15. To illustrate the changes that occur as a population's average consumption is increased, the distribution will be systematically shifted to the right and the percentage of the population above these cutoff values will be estimated. Since the normal distribution is based on an additive process the consumption levels will be increased by adding 1 unit to the consumption levels. The results are shown in Table 2 for the normal distribution N(5,5)

Table 2 Relationship Between Mean Consumption and the Proportion of "Heavy Consumers" for the Normal Distribution N(5,5)

Mean Consumption	Increase in Mean	% Above Limit	Increase in Percentage
5	0%	2.5%	0%
6	20%	5.2%	108%
7	40%	8.1%	224%
8	60%	10.9%	336%
9	80%	13.8%	452%
10	100%	16.4%	556%
11	120%	18.7%	648%
12	140%	20.6%	724%
13	160%	22.7%	808%
14	180%	24.2%	868%
15	200%	25.8%	932%

From Table 2 one can see that a three fold increase in mean consumption, from 5 to 15 units, results in a corresponding increase of ten times in the proportion of the population defined as heavy consumers from 2.5% to 25.8%. Fitting this relationship to a power function of the form $y = \alpha x^{\beta}$ one obtains $y = 0.15x^{2.0}$, where y is expressed in terms of a percentage. The correlation coefficient for the regression is 0.97.

Clearly an exponential relationship between mean consumption and the proportion of heavy consumers when the group occupies the range from a few percent to ten or twenty percent of the population is to be expected and it is found in distributions such as the normal distribution as well as the lognormal distribution, as noted by Ledermann (1956).

Development of the Distribution of Consumption Theory

Early Development, - 1956 to 1975. Initially the Lederman (1956) model generated relatively little research interest. Its principal proponents during this period were Wolfgang Schmidt and Jan de Lint of the Addiction Research Foundation of Ontario (Skog, 1973). As a result of their efforts the model became a central element in the influential book Alcohol Control Policies in Public Health Perspective (Bruun et al., 1975) and moved from relative obscurity to a significant and useful model of alcohol consumption in a population.

During the early 1960s de Lint and Schmidt undertook a major study of wine and spirit purchases in the province of Ontario (de Lint & Schmidt, 1967; 1968). Sales of alcoholic beverages were controlled by Government regulation and wine and spirits were sold through government retail stores. Individuals purchasing from these stores were required to complete a purchase form on which they detailed their intended purchases. Purchasers were also required to include their name and address as well as the date. The study collected 63,000 transactions from stores in five representative areas in the Province of Ontario. The characteristics of the purchase patterns were found to be consistent with the lognormal model. Approximately 62% of all purchases were for small quantities (0.5 to 2 bottles per month) and these purchases accounted for 20% of the total purchases. In contrast seven percent of all purchases were for more than ten bottles, and these transactions accounted for 40% of all sales. As well two percent of the purchases were for 18 bottles or more and these accounted for 20% of the total. The authors compared the theoretical lognormal model to actual purchases and found a good fit. Unfortunately no statistics of the comparison are given but a visual inspection of the graph of predicted and actual values shows a very good fit. By way of explanation for the shape of the curve the authors offer social pressures as well as the pleasurable effects of alcohol as contributing factors. Although de Lint and Schmidt recognize the limitations of equating purchases with individual consumption, nevertheless the study provided significant empirical support for the Ledermann model.

Smart and Schmidt (1970) undertook a review of five previous studies that had measured the blood alcohol content of drivers not involved in accidents. The data when plotted generally shows the lognormal shape despite the fact that in some cases the data were grouped into relatively broad ranges. Using a measure of skewness as an indicator of lognormality they concluded that all five sets of data meet the criteria of lognormality. They also reported that skewness and thus distribution shape varied with the distribution mean. The authors draw the strong conclusion that the results suggest that only a reduction in the average blood alcohol level will result in a reduction in the number of impaired drivers and that as a result preventative measures addressed only to the problem drinkers are unlikely to be effective. The results and conclusions drawn by Smart and Schmidt did not escape challenge (O'Neill, 1971). Fitting the data of Smart and Schmidt to a two parameter lognormal model O'Neill (1971) found that one of the five data sets differed significantly from a lognormal distribution and that the proportion of the populations above 0.08% blood alcohol content did not depend on the mean of the population.

In subsequent studies de Lint and Schmidt applied the distribution of consumption model to research and policy issues. In their first application (Schmidt & de Lint, 1970) the authors compared several methods of estimating the number of alcoholics in a population including the use of the distribution of consumption model of alcohol consumption. All of the methods produced similar estimates for the number of alcoholics in the Province of Ontario. Interestingly Schmidt and de Lint note that there is a substantial body of evidence indicating that the lognormal curve applies to a range of drinking populations and state that the form of the distribution appears unalterable, however the authors provide only two references to support this claim, Ledermann's original book (Ledermann, 1956) and their study of wine and spirit purchases in Ontario (de Lint & Schmidt, 1968).

Building on their previous paper de Lint and Schmidt (1971) then utilized the distribution of consumption model to estimate the percentage of alcoholics in various populations. The authors note that a close relationship between per-capita consumption in a population and liver cirrhosis mortality has been demonstrated and that the death rate among alcoholics, who consume significant levels of alcohol, from cirrhosis of the liver is much higher than the general population. The authors use the distribution of consumption model to bridge these two findings because it provides a means of relating population consumption averages for alcohol to the consumption levels of heavy consumers, or alcoholics, who develop cirrhosis as a consequence of their alcohol consumption. Thus the distribution of consumption model, with its relationship between the mean and heavy consumption levels, provided a way of estimating the number of alcoholics in a population. The authors also draw public health recommendations from the use of the distribution of consumption model, i.e., that measures should be taken to reduce the overall consumption levels of alcohol to reduce the levels of heavy drinking and the problems associated with these levels. Specifically they recommend taxation and control measures that reduce the availability of alcoholic beverages as means of decreasing the rates of alcoholism. They also call into question programs aimed at producing desirable drinking patterns suggesting that such programs would lead to higher overall levels of drinking and thus higher levels of alcoholism.

In a paper at the end of this period, de Lint utilized the distribution of consumption model in the assessment of trends in the excessive use of alcohol (de Lint, 1975). De Lint points out that there has been a significant rise in alcohol consumption levels in many countries due to a diffusion of drinking patterns from high consumption countries to low consumption countries, a relaxation of government alcohol controls and increased affluence. Utilizing the distribution of consumption model of alcohol consumption and data that relates excessive alcohol consumption and health related problems de Lint makes the case that alcohol related health problems will increase significantly with the increased alcohol consumption of the 1960s and 1970s. De Lint attributes much of the increase in consumption to the relaxation of government control policies and he recommends the re-establishment of such control programs to stem the trend towards an increase in alcohol related health problems.

Not surprisingly the distribution of consumption model attracted the attention of other researchers. Although more critical of the model than de Lint and Schmidt they nevertheless accepted the main features of the model. Room (1973) notes that the skewed lognormal distribution describes a range of natural phenomena and in particular is consistent with Floyd Allport's findings of similar distributions for conformity to a variety of normed behaviours (Allport, 1934). Although accepting of the general principle of a skewed lognormal distribution Room raises concerns about the application of the model. He points out that the lognormal distribution of consumption is not inherently limited to a specific shape or variance, but rather the proportion of heavy drinkers can vary independently of the mean if the variance changes. As a result preventive measures do not have to apply to all consumers, as a price increase does, but rather can be addressed to specific portions of the population.

Interest in the distribution of consumption model was also raised among Scandinavian researchers. Skog (1973), like Room (1973), accepts that a skewed lognormal distribution describes a range of phenomena including alcohol consumption but that this does not necessarily imply an acceptance of the Ledermann model which states that there is a fixed link between the population mean and the percentage of heavy consumers. Nevertheless, Skog's review of 17 studies, 10 from Ledermann and seven from the literature show a good relationship between the population means and the percentage of heavy consumers (10 cl. of alcohol per day). The data also show variations in the percentage of heavy consumers for populations with similar mean consumption levels. This suggests that it may be possible to influence the heavy consumers without changing the mean consumption level.

At the end of this 20 year period Bruun et al. published the influential book Alcohol Control Policies in Public Health Perspective (Bruun et al., 1975). The authors define public health as relating to the physical, mental and social well-being of a population, and alcohol control policies as strategies employed by governments to impact the availability of alcohol. The authors admit that their definition of alcohol control policies is narrow and does not make reference to societal values and attitudes that could be influenced by public education. Given these definitions of control policy and public health, the authors were faced with several challenges. First they had to establish the link between alcohol consumption in a population and health related problems in that population. Second they had to demonstrate that control policies that regulated the availability of alcohol would impact the number of alcohol related problems in a population. The authors demonstrated the first relationship by reviewing the fairly extensive literature that existed prior to 1975 that related health problems to the overall level of alcohol consumption in a population and to individual levels of consumption. Based on the literature review a great variety of health problems were shown to be related to alcohol consumption levels, e.g., neurological, digestive, respirator, cardiovascular, cancer, and injuries from accidents. At that time there were three broad models of alcohol consumption, alcoholism, the socio-cultural and the distribution of consumption model. Of these only the distribution of consumption model provided a mechanism that could relate availability and control policies with excessive consumption and health related problems. Their review of the literature to 1975 shows, as we have seen earlier, that the empirical evidence generally supports the assumption that alcohol consumption is lognormally distributed and that there appears to be a relationship between the mean consumption in a population and the proportion of heavy consumers in that population. Although the authors have no explanation to offer for the observed regularities, they do suggest that an individual's social milieu may influence an individual's drinking level. Having established the basis for their case the authors then review a variety of control measures that had been used in the past, such as, age limitations, limitations on the number of outlets and on hours of sale, alcohol content, limitations on advertising, and taxation. After presenting evidence that showed that such measures have been effective in the past in regulating availability and consumption, the authors conclude with strong recommendations that similar measures be utilized in the future to reduce the problems associated with excessive alcohol consumption.

A paper in the final year of this two decade period reviewed the two main models of alcohol consumption that were current at that time, the sociocultural model and the distribution of consumption model (Whitehead, 1975). A literature review of the sociocultural model, which sees alcohol consumption patterns resulting from conformity to cultural norms, showed that an extensive body of empirical support existed. For example, numerous studies of cultural subgroups, such as the Irish or Jews, had demonstrated dramatically different patterns of alcohol consumption and rates of alcoholism. Similarly a body of empirical support existed for the distribution of consumption model of alcohol consumption. Whitehead suggests that the models could be mutually complementary but that the specific conclusions and policies that proponents draw from one of the models tend to contradict the principles of the other model. As a result the models appear to be competitive. Whitehead's suggestion of a complementary relationship is rather interesting because, as noted earlier, reviewers of the distribution of consumption model have offered conformity to social norms as a basis of understanding the lognormal behaviour of consumption in a population. Whitehead's observation of the complimentary nature of the model is a rather prophetic one, because the development of the distribution of consumption model subsequent to 1975 would result in the development of a sociological basis for the distribution of consumption model of alcohol consumption.

In summary, the two decades after Ledermann introduced the basic elements of the distribution of consumption model (Ledermann, 1956) saw its promotion, primarily by de Lint and Schmidt, into a prominent model that provided the basis for an approach to public health policy that promoted the restriction of availability as the principal means of managing the health related problems of alcohol and alcoholism.

Development of the Model - 1976 to 1985. During the next decade the distribution of consumption model generated considerably more interest than in the first 20 years. The principal feature of this period was the development of the model by Ole-Jørgen Skog and this section will deal primarily with this development. The support, criticism and application during this period will also be addressed.

As noted in the previous section most of the early pioneers in the development of the distribution of consumption model proposed to varying degrees that social forces or factors likely played a role in determining the pattern of consumption in a population. A parallell had been drawn with Floyd Allport's analytic research on conformity to social norms which produced similar distributions of behaviour (Room, 1973). Treating the initial Ledermann hypothesis as a starting point (Ledermann, 1956), Skog (1977) began this decade by expanding the implicit assumptions of social factors into an explicit assumption, since the consumption of alcohol beverages is a social act that is strongly influenced by the drinking patters of a persons social milieu, then this social interdependence of alcohol consumption is an important factor in developing and maintaining the consumption patterns in a population. In typical fashion, Skog attempts to make a mathematical model of such interactions to help evaluate the assumption. The mathematical model assumes that individuals are influenced by 1) cultural norms, 2) the drinking levels of other individuals they interact with, and 3) by psychological and biological factors unique to the individual. Consistent with the Ledermann hypothesis Skog also assumes that the various factors combine multiplicatively. Without going into the mathematical details of the simulation, by expressing the above assumptions mathematically and making simplifying assumptions about an individual's initial level of consumption, the influence of the overall consumption level and the interaction between individuals Skog was able to simulate the steady state behaviour of a small group of 39 individuals. Despite simplifying assumptions, such as the allocation of individuals randomly to a bimodal distribution of personal tendencies towards consumption, the overall distribution of behaviour approaches a lognormal distribution. Simulating the effects of randomly selecting 10% of the individuals in the simulation sample with low consumption tendencies and converting them to high consumers results in an increase in consumption for all members of the simulation. However the higher consuming individuals in the simulation show less increase than the lower consumers. Overall these simulation findings are consistent with the empirical data on alcohol consumption and provide support for the Ledermann hypothesis in general and for the assumption that social interactions play an important role in the determining the distribution of alcohol consumption in a population.

In reviewing the application of the distribution of consumption model to public health policy Skog (1977) takes exception to the contention that the only way to reduce levels of high alcohol consumption is to reduce the mean consumption level. He contends that this conclusion does not have a scientific foundation and was a premature generalization. Building on the importance of social factors in shaping consumption levels Skog suggests that cultural or social forces may be utilized by a society to influence the dispersion of consumption without having to employ restrictive control measures such as proposed by Brunn et al. (1975).

In 1977 when Skog presented his initial ideas on the role of social interaction in shaping the distribution of alcohol consumption (Skog, 1977) there was a limited number of studies with which to test these ideas empirically. At the end of the 1970s a much larger number of population surveys had been carried out enabling Skog to test his assumptions of the role of social interactions and the distribution of consumption (Skog, 1985b). He reviewed fifteen of the studies in detail and fitted each to a lognormal distribution in a consistent manner, something that many of the study authors had not done. Although we will not review the studies in detail two studies are of interest. The first measured alcohol consumption in Iowa (Fitzgerald & Mulford, 1981). The study compared population surveys of Iowa in 1958 and 1979, a period during which the per capita sales of alcoholic beverages increased 55%. It would have been predicted on the basis of the distribution of consumption model that there would be a corresponding increase in heavy consumers, however no such increase was found. Instead there was a decrease in the number of abstainers and an increase in the proportion of light and moderate consumers. The study, in contrast to most other alcohol studies, utilized a quantity-frequency index as a measure of consumption. The rationale behind such a measure is that the pattern of drinking as well as the amount are factors that influence the negative outcomes of alcohol consumption. Skog suggests that the failure to find the expected increase in heavy consumers may be due to the use of the quantity-frequency index. Such an argument highlights a key assumption that is often implicit in the various studies on alcohol consumption. By focussing primarily on overall consumption of an individual, it is clear that the authors of these various studies believe that it is an individual's consumption level that is the primary determinant of alcohol related problems. If other measures, such as quantity-frequency measures, should prove to be better indicators of alcohol related problems then the public health conclusions to be drawn from the distribution of consumption model may well differ from the conventional ones. The second study analysed consumption under the "Bratt system" (Norstrom as cited by Skog, 1985). The Bratt system was a system of rationing that extended from WW I to its repeal in 1955. Survey data in 1954 showed a distribution with much less skew than would be expected from survey data from other countries, while a 1967 survey showed an increase in mean consumption of 29% and a distribution of alcohol consumption typical of those found in other countries. Skog points out that such findings demonstrate that the dispersion of the distribution is very much a product of social conditions. We can infer from this that there is not some inherent "law of nature" that relates the mean and the percentage of heavy drinkers above a fixed limit.

By analysing the properties of the distributions from the various studies Skog was able to draw a number of inferences from the data that lend support to the assumption that collective social behaviour is an important factor in the determination of the distribution of alcohol consumption in a population (Skog, 1985b).

First, using the percentage of a population that consume more than two times the mean as a measure of population dispersion or skewedness Skog found that this percentage fell in the 10% to 15% range. The only exception was data from a French sub-population of heavy consuming males. The basic assumption of lognormality does not constrain the value of the dispersion of the distribution. Although the measure is a relatively simple measure of dispersion the general similarity of dispersion in the various populations suggests that there are common forces in the various populations that tend to produce somewhat similar dispersions. The most likely common factors are cultural and social since attitudes towards drinking were becoming more liberalized and uniform in Europe and North America.

Second, although all the distributions have the general skewed shape of the lognormal distribution they do not fit the lognormal form exactly. The principal deviation is in the tail of the distribution which diminishes more rapidly than the theoretical distribution. Skog examined these deviations in more detail (Skog, 1985b). After eliminating surveys with a small sample size, only utilizing populations with comparable social and demographic characteristics and utilizing studies with both males and females represented, Skog found that in the 25 studies meeeting these criteria there was a relationship between the mean consumption and the proportion of heavy consumers. Specifically the relationship was of the form:

$$P(m) = \frac{am^b}{(1 + am^b)}$$

where P(m) is the proportion of the sample above a specific limit, m the average consumption of the sample, and a and b are constants. When P is small then the prevalence rate can be approximated by:

$$\frac{P(m)}{(1 - P(m))} = am^b$$

a power function. Defining heavy consumption as five centilitres of alcohol per day Skog found for the 25 studies that a=0.0028, b=1.75, and the residual error was 22%. For a heavy consumption limit of 10 centilitres per day it was found that a=0.00043, b=1.99, and the residual error was 36%. Although these findings support the general hypothesis the levels of error indicate that there is considerable variation from population. Similar results are obtained if one plots percentiles, e.g., 25%, 50%, 75%, 90%, and 95% against average consumption suggesting that the population as a whole increases its consumption not just the higher level consumers. The relationship is of the form:

$$X_p = cm^d$$

where X_p is the p^{th} percentile, c and d are constants and m is the average consumption of the population. The results generally support the conclusion that populations increase their consumption as a collective whole. However the exponent for the various percentile levels reveals that there are differences in the rates at which the population segments increase their consumption in relation to the mean. The exponents for the 25, 50, 75, 90 and 95 percentile were found to be 1.30, 1.18, 1.08, 0.95, and 0.88 respectively. These results suggest that, although all segments are increasing consumption levels as the mean increases, the lower consuming segments show a greater rate of increase. Skog attributes this to the fact that the populations are heterogeneous rather than homogeneous. Various sub-populations, e.g. males versus females, will have lognormal distributions but since they have different means the actual shape of the distributions will differ. Adding these different distributions together results in a distribution that deviates from the theoretical lognormal distribution. Although not noted by Skog another factor that may contribute to the deviation from the theoretical curve is the negative effects of alcohol itself. Increased alcohol consumption can lead to social pressures to reduce consumption levels and negative social, health, and employment consequences. These negative consequences may temper the growth of the high consuming segments of a population when the overall population consumption level increases.

The assumption of subpopulation differences was tested by comparing gender differences in the distribution of consumption. Analyzing 18 female and 22 male studies Skog found that the subpopulations were generally lognormal in shape, differed in mean consumption levels and also differed in dispersion, with the female subpopulations having a lower mean consumption and the female distribution of consumption less dispersion than the male distribution.

Collectively these findings provide support both for the lognormal hypothesis and for the hypothesis that populations behave in a collective manner with respect to alcohol consumption. Although Skog (1985b) acknowledges the role of biological and psychological factors in influencing an individual's consumption level he concludes that the findings indicate that social and cultural elements are the most important factor in determining how many individuals in a population will become heavy drinkers.

In focussing on the collective social behaviour of a population and of groups within a population Skog had addressed the primary weakness of the Ledermann hypothesis (Ledermann, 1956) which was the lack of any theoretical explanation for the phenomena (Skog, 1977; 1985b). In consolidating his ideas and presenting them as a unified approach Skog (1985b) addressed both the lack of a theoretical underpinning for the distribution of consumption model and integrated the distribution of consumption model with the sociocultural model. He has put forth two main hypotheses as a basis for the theory of the distribution of consumption. First that the factors that contribute to the amount of alcohol an individual consumes combine in a multiplicative manner. As we have seen in the review of the lognormal distribution and its properties one of the key elements that give rise to the lognormal distribution in a natural population is the multiplicative combination of contributing factors. The second hypothesis is the important role of social interaction in shaping an individual's consumption level and the collectivity of consumptive behaviour in shaping the overall distribution of consumption in a population. To support his approach Skog draws on the ample body of evidence, which has already been reviewed, that provides support for the lognormality of the distribution and the importance of social interactions in the distribution of alcohol consumption. This presentation of the complete model addressed the lack of a theoretical basis for the Ledermann hypothesis (Ledermann, 1956), established the distribution of consumption model in its present form, and integrated the two main models of alcohol consumption, the sociocultural model and the distribution of consumption model.

During this period of development of the distribution of consumption model not all researchers supported it. Two particularly strong critics were Duffy and Cohen (1978) and their work can be taken as representative of the criticisms of the model. Two initial criticisms of the Ledermann hypothesis (Ledermann, 1956) made by Duffy and Cohen were that he did not present any convincing argument for the population distribution being lognormal and that Ledermann did not define a homogeneous population. The first criticism, the lack of any convincing theoretical argument in Ledermann's work, is indeed a valid one. As noted earlier Ledermann provides by way of explanation only limited and rather cryptic references to a contagion or a snowball effect, hardly an adequate basis for such a wide ranging model. The subsequent work of Skog (1985), which was not available at the time that Duffy and Cohen wrote their critique, has addressed this weakness and placed the Ledermann hypothesis on a sounder theoretical basis. Their second criticism, a lack of definition of a homogeneous population is true of both Ledermann's and Skog's approaches (Ledermann, 1956; Skog, 1973). The lack of a theoretical definition likely reflects the difficulty of developing one that can realistically apply to a real world population. Since alcohol consumption is the result of a combination of biological, social and psychological factors, a homogeneous sub-population would presumably be one in which the same set of factors was applicable to each individual in the population. Although this definition of a homogeneous sub-population may appear plausible at first in practice there are a wide range of factors that must be considered. For example, in the area of social and cultural factors, numerous broad categories such as gender, ethnic background, education, socioeconomic status, religion, occupation, geographic region, among others. must be taken into account. Each of these categories has a number of different sub-levels, e.g., years of education. With such a range of factors it may not be possible to realize homogeneous subgroups in practice. For example if there were only 10 different cultural factors each with only four possible sub-groups each then there would be 1,048,576 possible homogeneous categories. If the overall population size was 100,000,000 then each homogeneous category would contain an average of 100 individuals. Expanding the list of factors to include a wider range of social factors and adding psychological and biological variables the number of distinct homogeneous subgroups would begin to approximate or even exceed the number of individuals in a typical national population. Clearly, in practice, the theoretical definition of a homogeneous sub-population leads to sub-groups too small to be meaningful in terms of a distribution of consumption model. Thus, one will always be dealing with heterogeneous populations and as a result analysis should be concerned with how well the distribution of consumption model describes these populations.

Duffy and Cohen (1978) also criticise the Ledermann hypothesis (Ledermann, 1956) for its assertion that the distribution of alcohol consumption can be described by a single parameter, the mean. They note that there is no theoretical necessity for assuming a relationship between the mean and variance of a lognormal distribution and thus no theoretical reason to assume a relationship between the population mean and the proportion of heavy drinkers in a population. Ledermann asserts that there is a strong link between the mean and the proportion of heavy drinkers in a population but this assertion was based on limited data. Skog's analysis of the much larger amount of data available to 1985 (Skog, 1985b) shows that although an exponential relationship can be fitted to the mean and the proportion of heavy consumers of alcohol, this relationship is not exact and has significant error variance associated with it. Skog's interpretation of the association of the mean and the proportion heavy consumers in a population is that the relationship indicates that there are broad trends across populations but one should be cautious in using the relationship to predict the precise behaviour of a particular population. These results can be understood within the context of Skog's social interaction extension of the Ledermann model. Skog has postulated that social interactions, which result in a collective behaviour within a population, are one of the most important factors influencing the shape of the consumption distribution. Almost all survey data available to Skog were from European and North American, countries that in the post war period could reasonably be expected to have somewhat similar cultural attitudes towards alcohol and alcohol consumption based on the social interactions between the various countries. Based on such similarities one would expect a broad relationship across countries with some individual deviations and this expectation is consistent with the data.

Duffy and Cohen (1978) also point out that when fitting a lognormal curve to the data the central 80% to 90% is a good fit while the tails do not provide a good fit. Skog has also noted a declining relationship between mean consumption levels and the proportion above various levels of consumption (Skog, 1993). Within the context of the expanded Ledermann model there are two plausible interpretations of this declining relationship. First, the negative effects of heavy alcohol consumption may result in lower increases in the consumption of high consumers than would be expected from the increase in the population mean. Second, since the extended model assumes that actual consumption levels are determined by multiple factors, we could expect that high consumers have more contributing factors and/or more severe factors. As the contribution of psychological and biological factors increases one would expect the relative contribution of social factors, as represented by the mean consumption level, to also decline. Both factors likely operate in combination and provide a plausible explanation for the decline noted by Skog and by Duffy and Cohen.

A significant part of Duffy and Cohen's (1976) criticism is a rejection of the Ledermann model (Ledermann, 1956) because it fails to conform exactly to the theoretically predicted lognormal shape. They object to other authors accepting the Ledermann model because it provides a reasonable rather than exact fit and accuse the supporters of the model of taking refuge in its theoretical vagaries and ambiguities. To be fair to Duffy and Cohen it should be noted that their criticism was made before the extension of the model by Skog (1985). Although one can dispense with part of this criticism by pointing out that the theoretical limitations of the Ledermann model have been addressed by Skog (1985), there is a significant point that is raised by Duffy and Cohen's criticism, i.e., what criteria are to be used to judge such a model. The implication of Duffy and Cohen's argument is that the model should be rejected because real world data fails to match the theoretical model exactly. However, in the social sciences no one model has been able to explain and predict human behaviour to the same level as is found in the physical sciences. In the physical sciences models such as Newtonian mechanics or relativistic mechanics explain and predict a wide range of physical phenomena with a very high degree of accuracy. In the social sciences no one model has proven able to deal with the complex interaction of biological, psychological and social factors that influence behaviour in the real world. Not surprisingly, individual models or theories are typically less than perfect in describing sociological/psychological phenomena, and often a relationship or correlation between variables of $r = 0.3$ or higher is considered a good result. A correlation coefficient of 0.3 corresponds to an explained variance (R^2) of only 10%. The existence of multiple models with limited predictive ability provides no obvious rationale for setting the acceptance criteria in the case of the distribution of consumption model. Rather than attempting to set an arbitrary, and possibly indefensible, minimum criteria of explained variance for the distribution of consumption model a priori, a utility of knowledge approach provides a more practical alternative. In this approach information on the explained variance is provided to allow the user of the model to judge its utility for a specific application. For example, a model that explained 80% of the variance would be a powerful model for most applications, and substantially better that the typical model in social sciences, while an explained variance of 10% to 15% is of low utility unless combined with or representing an improvement over other models. In the utility of knowledge approach the acceptability of a model is judged by the user and the researcher's job is to provide sufficient information to allow an informed opinion to be made. For our purposes here the model will be judged in terms of its utility in informing public health policy.

The statistical approach, of performing a statistical test of normality of the logarithm of the consumption variable is not applicable here. Consumption studies often have a sample size of several thousand or more, a size that gives high levels of statistical power to such tests. As a result, even small and insignificant variations that might result either from deviations from theory or from biases in the survey and measurement methods would result in statistically significant deviations from the hypothetical model . For this reason conventional statistical tests of normality are of limited value in testing such models.

In summary, most of the key criticisms that were levied against the Lederman hypothesis (Ledermann, 1956) have been addressed by the subsequent development and extension of the model by Skog (1985). Two criticisms remain, the lack of a definition of the construct of homogeneity and a lack of a statistical criteria for the acceptance of the model. As we have seen a theoretical definition of homogeneity is difficult to realize in the practical world and as a result the most appropriate approach is to assess how well the model does in describing real world populations rather than some theoretical entity. This can be done by estimating the predictive accuracy of the model, e.g., calculating the average error of prediction for the population of interest. From a public health perspective the utilization of real world populations is clearly the most desirable approach. The second criticism can be effectively addressed by applying the utility of knowledge approach to evaluating the model rather than an arbitrary and indefensible fixed criteria. This approach also enables one to judge the model's utility from a public health perspective.

Recent Developments of the Model - 1986 to 1998. As noted previously the post WWII increase in alcohol consumption had produced a corresponding increase in alcohol related problems. These increases provided the motivation to find means of reducing the public health consequences of alcohol. The distribution of consumption model of alcohol consumption developed initially by

Ledermann (1956) postulated strong relationships among consumption levels, excessive consumption and alcohol related problems. Two factors were important for the model's acceptance. First, it was consistent with the general post war experience with rising alcohol consumption and increasing problems, and second, it appeared to provide a ready solution to alcohol-related problems - the reduction of alcohol consumption by reducing its availability. Although the theoretical development of the model by Skog (1985) highlighted the importance of social and cultural factors in determining the distribution of consumption in a population, the emphasis continued on the reduction of average consumption levels as the means of reducing alcohol related problems. Interestingly the increase in alcohol related problems began to slow in the mid 1970s and then to decline and this decline has continued to the present. Although these declines were associated with a stable or declining consumption levels, decreases in alcohol related problems have in many cases been larger than would have been expected from the declines in consumption levels (Mann & Smart, 1990). As Mann and Smart (1990) point out these changes offer the possibility of utilizing epidemiological studies to gain greater understanding of the nature of the change in alcohol related problems. Thus a review of the period 1986 to 1998 will include both an examination of the continued development of the distribution of consumption model and a review of the studies examining the recent decline in alcohol related problems.

The primary period of development of the distribution of consumption model occurred during the decade 1975 to 1985 and at the end of this period the model essentially took its current form. Skog has utilized an alternate way of viewing the dynamics that underlie the lognormal distribution in a population by taking an actuarial approach (Skog, 1993; Taylor, 1979). This approach calculates the consumption containment rate for various ranges of consumption. To illustrate the concept of the consumption containment rate let us assume that the annual alcohol consumption of a population is divided into ranges of litres of alcohol consumed per annum, e.g. 0 to 1 litre per annum, 1 to 2 litres per annum, etc. Typically such distributions are described by measuring the frequency or probability or each range, for example 10% of the population consume 10 to 11 litres of alcohol per annum. Such an approach gives the probability that any individual will be found in a particular consumption range. As an alternate to this absolute probability one can calculate the conditional probability of a person being in the 10 to 11 litre per annum range given the percentage of individuals who consume 10 litres or more. To illustrate, let us assume that half of the population consumes 10 litres of alcohol per annum or more. Then the conditional probability of being at the 10 to 11 litre consumption level out of all those whose consumption exceeds 10 litres is 10%/50% or 20%. Such rates are utilized by actuaries to estimate the percentage of individuals who will die at a specific age out of all who have arrived at that range, e.g., the percentage of those who reach age 50 who will die in their 50th year. Although the actuarial use implies a steady progression through the age ranges, in the case of alcohol consumption individuals do not inexorably increase their consumption rates; rather, social, psychological and biological factors influence an individual's consumption level with the result that some individuals increase their consumption, some decrease their consumption and the consumption of others remains essentially the same. If the distribution of consumption in a population is stable, then the number of individuals in each consumption range is stable and so are the absolute and conditional probabilities. Although the number of individuals in each range is stable, individuals will likely change their consumption with time and migrate from one consumption range to another, even individuals with high consumption rates (Cahalan & Room, 1974; Clark & Cahalan, 1976; Skog & Duckert, 1993).

Skog (1993) has calculated and plotted the consumption containment rate to 24 population surveys from 11 countries. The results indicate that in sample populations with low to moderate average consumption levels (less that 10 litres of alcohol per annum) the consumption containment rates typically decreased with increased consumption. For populations with moderate to high average consumption levels (10 to 20 litres of alcohol per annum) the consumption containment rates were generally stable across consumption ranges. For high consumption populations (greater than 20 litres per annum) the consumption containment rates increase at high consumption levels. For low consumption levels (less than 10 litres of alcohol per annum) the consumption containment rate is well above 0.1 and for high consumption levels it is well below 0.1. The consumption containment rates of the highest consumption levels in all populations, i.e., the tail of the distribution, tend to converge suggesting that the dynamics of this segment are similar across populations. It should be noted that it is the consumption containment rate and not the prevalence of heavy consumers that converges across populations.

Skog (1993) makes the interesting suggestion that the consumption containment rate can give insight into the underlying population dynamics. The drinking patterns for individuals vary over time even for individuals in the tail of the distribution (Cahalan & Room, 1974; Clark & Cahalan, 1976; Skog & Duckert, 1993). As a result in a stable distribution individuals are steadily entering and leaving the various categorical levels of consumption. It is not surprising that in populations with low average consumption Skog found high consumption containment rates. These rates reflect the fact that in such populations the forces that impinge on individuals tend to restrain an increase in consumption level. The low consumption containment rates found in populations with high average consumption levels reflect the lower number of factors that restrain consumption. The convergence of the consumption containment rates at the high consumption levels, i.e., the tail of the distribution, suggest that similar factors influencing consumption at these levels exist across populations. Skog suggests two possible explanations. First, that there are biological limits to the amount of alcohol individuals can consume, and second, that the "natural history" of alcoholism may have a structure that influences consumption. Although Skog does not mention it in the research article, the consumption containment rate measures only half of the population dynamic, that of increasing or staying the same. There is a corresponding contingency probability that would measure the probability of staying at the same level or of decreasing consumption. This rate would be calculated in an analogous manner and include the population at and below a specific consumption range.

In summary, the application of the consumption containment rates to the lognormal alcohol consumption curves (Skog, 1993; Taylor, 1979) provides an alternative description of the distribution of consumption that reflects the underlying dynamics in the population. The approach illustrates the different dynamics found in populations with low average consumption levels as compared to populations with high average consumption levels. The populations with a low average consumption have a higher conditional probability of an individual remaining at a specific level of consumption than populations with high average consumption. Since it is reasonable to assume that psychological and biological factors that influence alcohol consumption are similar in the various countries of Europe and North America, it is reasonable to conclude that it is the social and cultural forces in these populations that determine the number of individuals who consume various levels of alcohol.

One of the key assumptions of the distribution of consumption model has been its lognormal form, although, as we have seen, typical population samples of alcohol consumption usually do not follow this shape exactly. An alternative approach has been suggested which relaxes the assumption of lognormality (Tan, Lemmens, & Koning, 1990) and replaces it with the assumption of consistency of form over time. Specifically the assumption is made that if $D_1(x)$ and $D_2(x)$ are distributions describing a population at two points in time then the distributions are related by:

$$D_1(x) = D_2(\tfrac{x-a}{b})$$

This assumption has been found to apply to the logarithm of alcohol consumption data from Holland from 1970 to 1985 (Tan et al., 1990). The approach provides a potentially useful way of analysing population distributions that have significant departures from the lognormal form. However, the authors do not propose a theoretical basis for their approach and as a result, at this point in time, the approach does not advance our understanding of the population dynamics of alcohol consumption.

Support for the importance of social influences on alcohol consumption comes from social learning theory (Akers, 1991). Sociological theories, in general, emphasise social, cultural and social psychological variables as a basis of understanding consumptive behaviours. Alcohol and drug consumption varies between societies and sub-groups within societies, e.g., by age, sex, socio-economic status, class, religion, ethnic background, race, etc. Although biological and psychological variables may be involved, social and cultural factors are considered the predominant elements. Social learning theorists have taken a behaviourist view of drug or alcohol consumption. In this view an individual's behaviour is acquired through a social learning process which is influenced by rewards and punishments provided by society. The probability that behaviour will occur is increased by actual or anticipated rewards or positive consequences (positive reinforcement) and avoidance of punishment or negative consequences (negative reinforcement) and is decreased by aversive consequences (positive or direct punishment) and lack of reward (negative punishment). Thus differential rewards are the primary determinates of consumption levels. The principal reinforcers are considered to come from primary groups, such as family and friends and from secondary groups, such as the media; both providing reinforcements, exposure to norms and models of behaviour. Although the theory recognizes the presence of non-social factors, social forces are considered to be primary. For alcohol, negative reinforcement is considered to play an important role in alcoholism for a small percentage who develop a physiological addiction and use drinking to avoid withdrawal symptoms. The negative reinforcement effects are combined with the pleasurable effects of alcohol and with social rewards, e.g., sympathy and support from others and the mitigation of the consequences of drinking.

The "Boys Town" study of approximately 3,000 adolescents in the Midwest U.S. (Akers, 1991) provides evidence to support the social learning theory. The multiple correlation for social learning variables was found to be 0.74 with alcohol consumption and 0.56 with alcohol abuse. Similarly the correlations were 0.83 with marijuana use and 0.62 with marijuana abuse. These findings support Skog's contention that social interactions are the major factors in determining alcohol consumption (Skog, 1985a). The findings also support Skog's observation based on the distribution of alcohol consumption in various population samples that heavy consumers appear less influenced by social factors than light to moderate consumers.

Much of the support for the importance of social factors in determining the distribution of alcohol consumption has come either from the analysis of consumption patterns in various populations, (e.g., Skog, 1985a) or from the correlation between social learning variables and alcohol consumption levels (Akers, 1991). Although these approaches generally support the theory, they leave open the key question of whether or not social factors can actually be used to reduce alcohol-related problems in a real population?" The experience in Ontario from 1975 to the present provides real-world support for both the distribution of consumption model and the application of social factors to influence the levels of alcohol related problems (Mann, Smart, Anglin, & Rush, 1988; Smart & Mann, 1995; 1997). Canada, like many other countries, experienced a large increase in alcohol consumption and alcohol related problems in the period from 1945 to 1975. Alcohol consumption increased by approximately 50 percent, and liver cirrhosis doubled from 1950 to 1975. After 1975 both alcohol consumption and alcohol related problems began to decline in Canada. Utilizing data from Ontario, the relative importance of levels of treatment and self help programs, increased levels of health promotion, the price of alcohol, and the availability of alcohol were examined. The distribution of consumption model predicts that the decline in average consumption of alcohol would result in a decline of alcohol related problems and that this decline would be greater than the decline in the mean consumption level. The data for Ontario shows an overall decline of 19.1 % in alcohol consumption from 1975 to 1998. This decline was accompanied by a decrease in hospital separations from alcohol dependence of 66.4% and a decline in liver cirrhosis mortality rate 31.9%. As well, driving while impaired charges declined by 35% and drinking drivers involved in fatal accidents declined by

56.8%. Throughout this period the availability of alcoholic beverages increased slightly and the relative price of alcohol remained approximately the same. Large increases in the number of individuals in formal treatment or attending Alcoholics Anonymous were found during this period. Also, there were increases in employee assistance programs and self promotion programs in the workplace. Over this time period there was a steady increase in the proportion of students in Ontario who received alcohol education. The authors suggest that the data supports an interpretation that changes in treatment levels and prevention programs rather than changes in price availability are associated with the decline of alcohol consumption and problems related to alcohol in the Province of Ontario. In contrast, the belief of many who applied the distribution of consumption model to public health policy was that the only method of producing a decline in average consumption is to increase controls on alcohol and alcohol prices (Bruun et al., 1975). The results in Ontario do not support this premise. However, the large drop in alcohol-related problems do support the non-linear link between average consumption levels and heavy consumption. As well the role of prevention and education programs is consistent with the emphasis placed on social factors in the extended distribution of consumption model (Skog, 1985).

Further support for the distribution of consumption model comes from a causal modelling study of availability, consumption and alcohol related problems in the 49 counties of Ontario (Rush, Glicksman, & Brook, 1986). The study utilized LISREL (the analysis of linear structural relationships), an approach which allows the evaluation of a hypothesised model. In this case the model was based on the distribution of consumption model and hypothesised that availability would be causally related to consumption levels and that consumption levels would be causally related to both alcohol morbidity and mortality. Multiple measures for each of the model elements were obtained and utilized in evaluating the model. The LISREL process supported a causal link between availability and consumption, between consumption and morbidity and between morbidity and mortality but did not support a link between consumption and mortality. Overall the model explained 72% of the sample variance. These results provide good support for the distribution of consumption model by demonstrating a relationship between alcohol consumption and alcohol-related problems and for the public health claim that there is a relationship between availability and alcohol consumption levels. Unfortunately the study was unable to test the assumptions that there is a nonlinear relationship between overall consumption increases and the proportion of heavy consumers. This aspect of the model is supported only indirectly via the link between consumption levels and alcohol related problems. A comparison of U.S. national alcohol surveys from 1967 and 1984 also provide some support for the distribution of consumption model (Hinton & Clark, 1991). In addition to consumption this study was also able to compare 13 negative consequences of alcohol consumption between the two studies. Overall consumption in the samples was found to have increased 11.8% and the proportion of heavy consumers rose from 12% to 14%, a 17% increase but the difference was not statistically significant. Thus while the numerical increase tends to support the distribution of consumption model, the lack of statistical significance makes it unclear whether the increase in heavy consumers is the result of random differences from sample to sample or a valid difference that is not significant because of a lack of statistical power. Although there was an increase in the proportion of individuals experiencing one or more of the four problems related to alcohol dependence (8.2% to 18.8% for males and 5.2% to 8.2% for females) little difference was found in the number of respondents who experienced any of the nine negative consequences of alcohol consumption. Although the study does not contradict the basic elements of the distribution of consumption model it provides only limited support at best for the model.

Prevalence studies during this period have yielded only modest support for the distribution of consumption model. An examination of U.S. surveys between 1971 and 1981 (Hilton, 1988) generally reveal stability in drinking patterns. There were increases in some heavy consuming subgroups, e.g., males who drank more than 60 drinks per month, males and females who drank five or more drinks as often as once a week, and men who got drunk as often as once a week. Contrary to expectations these increases occurred between 1979 and 1984, a period of stable average alcohol consumption levels. An analysis of consumption patterns in the state of Iowa from 1961 to 1985 (Mulford & Fitzgerald, 1988) showed that while per capita alcohol sales doubled and the number of drinkers increased 27%, the prevalence of heavy drinking did not increase. One possible reason for this discrepancy is that the analysis utilized a quantity frequency index as a measure of consumption rather than the more conventional measure of consumption. It is possible that this measurement difference may have obscured the expected changes in consumption levels. In Iowa wine sales were privatised in in 1985 and spirits in 1987. This led to a dramatic increase in availability as measured by the number of off-premise outlets. Wine outlets increased form 214 to 800 and spirit outlets increased form 214 to 400. Surveys undertaken pre and post privatization did not show any significant increases in per capita consumption, neither did they show increases in heavy drinking rates. Although these findings do not challenge the distribution of consumption model itself they do challenge the public health assumption made by some proponents of the model (Bruun et al., 1975) that controlling availability is key to the reduction of alcohol related problems.

Summary. From Ledermann's initial observations that the distribution of alcohol consumption in a population could be described in terms of a lognormal distribution (Ledermann, 1956) his propositions have been developed into a model of alcohol consumption that views social factors as key elements in the determination of alcohol consumption in a population (Skog, 1985a). Populations that have been surveyed have generally displayed a lognormal distribution of alcohol consumption even though the fit is by no means exact. Ledermann's hypothesis that there is a relationship between the mean alcohol consumption level in population and the proportion of heavy drinkers has also received some general support but the relationship is not exact and significant variation exists between populations. The distribution of consumption model had aroused considerable interest as a basis for developing public health policy on alcohol. One group of public health proponents has emphasised the reduction of availability of alcohol as a key public health measure (Bruun et al., 1975). To do so they have linked availability, the distribution of consumption model and alcohol related problems. Although the literature provides general support for the links between alcohol-related problems, particularly cirrhosis of the liver, and consumption levels, as well as, some support for the link between average consumption and the proportion of heavy drinkers, there is mixed support for the link between availability and average consumption (Ravn, 1987a; Ravn, 1987b).

Alcohol Consumption and Alcohol Related Problems

In the biological sciences there is often a clear relationship or dose response curve between the dose of toxic substance and its impact on a population, e.g., the level of exposure to an insecticide versus the mortality rate in an insect population (Finney, 1964a; Finney, 1964b). Such relationships often follow a non-linear relationship with increased dosage. In the case of alcohol in human populations the situation is much more complex. Although individuals occasionally drink at levels that are either acutely toxic or toxic over a short period of time, most alcohol consumption is at levels well below toxic values. Consumption at these levels result in an increased risk of disease in a population and the diseases develop only over a period of time. This makes the determination of the effects of alcohol consumption on a population more difficult to assess. Alcohol consumption, both chronic and acute, has been implicated in a wide range of medical problems (Devenyi & Saunders, 1986) as well as in suicides, accidents, and drinking and driving (Bruun et al., 1975; Edwards et al., 1994). The key to understanding the relationship between alcohol consumption and alcohol related diseases lies in the interaction between the dose response curves and the form of the distribution of consumption in a population. Skog has noted that the interaction of a linear dose-response function and an arbitrary distribution function is independent of the form of the distribution function (Skog, 1982). The general form of the relationship is:

$$D_A = N\int r_A(x)f(x)dx$$

Where D_A represents the annual deaths from alcohol in one year, N the size of the population, $r_A(x)$ the dose response relationship, and f(x)the distribution of consumption function. Skog assumes that $r_A = \alpha + \beta x$, a linear function, and m the average population consumption. Then we have

$$D_A = N\int(\alpha + \beta x)f(x)dx$$

Since $\int f(x)dx = 1$ and $\int xf(x)dx = m$ we then have

$$D_A = N(\alpha + \beta m)$$

a linear function of the average consumption m and independent of the shape of the distribution of consumption in the population. As Skog points out that unless the dose response relationship is nonlinear one cannot draw the conclusion that there is a relationship between the properties of the distribution of consumption and the extent of alcohol related problems in a population.

In their review of the literature on the relationship between alcohol and a wide range of alcohol related disorders Edwards et al. (1994) find that alcohol related mortality follows a "J" curve, with higher mortality rates among abstainers than among light drinkers, and an increase in overall alcohol related mortality with heavy consumption. This dip in alcohol related mortality appears to be the result of a reduction in coronary heart disease produced by low levels of alcohol consumption. Nevertheless, for heavy alcohol consumers the overall alcohol related mortality curve appears to be a non-linear rising function of consumption. It is the interaction of the non-linear dose-response curve at the individual level with the distribution of alcohol consumption in a population that produces the overall population risk. The distribution of consumption model predicts that the distribution of consumption in a population is lognormal and that generally an increase in average consumption will produce a exponential increase in the number of heavy consumers. The combination of a non-linear increase in heavy consumption coupled with a non-linear increase in individual risk for heavy consumers has the potential to significantly raise the number of alcohol-related problems in a population. Generally dose-response curves are presented for the population as a whole and may give the impression that the aggregate curves apply to all sub-populations. It has been noted that the dose-response curves may differ between population sub-groups with some groups (e.g. upper occupational status groups) showing less vulnerability (Cartwright, Shaw, & Spratley, 1978a; 1978b)

The above analysis illustrates the focus on heavy alcohol consumers which has often been a part of alcohol-related public health policy. Clearly members of the heavy consumption group are at greatest risk, as individuals, for the development of alcohol related problems. The underlying assumption is that this group should be the prime focus of public health policy. However, this assumption has been challenged. The lognormal form of the distribution of alcohol consumption in a population suggests that there are relatively few heavy consumers of alcohol and a large number of moderate and light consumers. Although the risk of developing alcohol related problems declines with decreased consumption, when this low rate of risk is applied to the large number of low and moderate alcohol consumers in a population it is possible for these segments of the population to experience a total number of problems that is comparable to that of the heavy consuming segment of the population (Kreitman, 1986; Rose, 1981). This phenomena is known as the prevention paradox.

In summary there are two ways of viewing the interaction of the dose-response curves with the distribution of consumption in a population population. One approach focuses on individuals with a variety of significant problems. In the case of alcohol these individuals are typically in the high consumption segment of the population and in the past often received the label "alcoholic". Public health policy has often targeted this segment of the population with a variety of addiction treatment programs. The other approach takes a societal perspective and views each alcohol related problem as a cost to society whether it is experienced by a heavy consumer or a light consumer. Although the individuals in light and moderate consuming segments of a population may have relatively few or no problems, there are a large number of individuals in these population segments and collectively these segments may contain a significant proportion of the total alcohol related problems. The views are complementary and are both necessary if alcohol related problems in a population are to be significantly reduced. Logically, the relative proportion of effort expended on the various population sub-groups depends on the distribution of problems in a particular population.

Hypotheses and Methods

Project Goals and Benefits

The distribution of consumption model has been influential in the area of alcohol research and alcohol-related public health policy. It has, on the one hand, provided a theoretical understanding of the population dynamics that shape the overall consumption patterns in a population and an understanding of the factors that influence an individual's level of alcohol consumption. On the other hand, the model has also influenced the practical development of public health policies that attempt to minimize the societal harm that results from alcohol consumption in a population. Because of the similarities of gambling to other addictive behaviours it can be hypothesized that the distribution of consumption model will apply to gambling behaviour in a population. The overall goal of this research project is to test the applicability of the distribution of consumption model to gambling behaviour in a general population. The finding that the distribution of consumption accurately describes the distribution of gambling consumption in a population would result in a number of theoretical and practical benefits. First, the theoretical understanding of gambling behaviour will be expanded with a theoretical model that will help establish a scientific framework for understanding gambling behaviour. Second, this theoretical framework will help expand the existing individual-oriented models of problem gambling behaviour to one that is capable of describing a wide range of gambling behaviours in a general population. Third, such a model will help identify both the key factors that influence gambling behaviour and how these factors interact. Finally the model identifies potential preventative measures that can be utilized to develop public policies designed to minimize the negative impacts of gambling on a population.

Data Base

This research will utilize the Problem Gambling Research Group's community impact data base to evaluate the applicability of the distribution of consumption model to gambling behaviour. The data base consists of three surveys of the adult population of the City of Windsor. The first was carried out from September 1993 to April 1994, immediately prior to the opening of Casino Windsor. This survey collected data from 2,682 adults, 18 years and older. The second survey was carried out in 1995 approximately one year after the opening of Casino Windsor. It surveyed 2581 adults. The third survey was carried out in 1998, four years after the opening of Casino Windsor. This survey collected data from 2714 adults in the City of Windsor.

The data base is unique in its multi-year tracking of the impact on problem gambling in a community resulting from the introduction of a major new gambling venue. Although the data base was not designed to test the distribution of consumption theory, it contains sufficient demographic and gambling expenditure information to allow a reasonable evaluation of the applicability of the distribution of consumption model. There is also sufficient information to provide some evaluation of the secondary hypotheses on the dose-response relationship and the effect of increased consumption on average consumption.

Survey Methodology

Adults aged 18 and older were sampled by telephone from the Metropolitan Windsor area, i.e., the cities of Windsor, LaSalle, Maidstone, and Tecumseh. Randomization of households was achieved in a two stage process. First, approximately 2,000 telephone numbers were randomly selected from the current Windsor and Area telephone directory. The last three digits of each number were removed and replaced with a randomly generated three-digit number. This procedure enables the telephone survey to reach unlisted and new telephone numbers. Second, randomization within the household was achieved by selecting the adult resident with the next birthday rather than automatically interviewing the person answering the telephone. A number was called back up to five times on separate days if no answer was obtained. If the individual selected within the household was unable to complete the survey at that time a call back time was arranged if possible. Informed consent was obtained verbally before proceeding with the interview. The survey was conducted from 4:00p.m. to 9:00p.m. Monday to Friday, and from 12:00p.m. to 6:00p.m. on Saturdays. Survey staff were given an initial training program and ongoing supervision was provided.

Survey Instrument

The South Oaks Gambling Screen (SOGS) was chosen as the basis for this survey because it is the most widely used standardized survey instrument and allowed for comparisons with numerous other studies. The screen was adapted as suggested by Lesieur and Blume (1993) to reflect the gambling practices of the province of Ontario and to measure recent gambling behaviour as well as lifetime gambling behaviour. The survey instrument consists of five sections. The first section (questions 1 to 4) taps the respondents' attitudes towards the future Casino Windsor. These questions are designed to provide a non-threatening introduction to the survey for the respondents and to provide a lead in to the questions on gambling behavior. The second section (questions 5 to 84) is based on the SOGS screen (Lesieur & Blume, 1987) modified as suggested by Lesieur and Bloom (1993) to measure the prevalence of problem and pathological gambling for both the lifetime and the previous year. A copy of the SOGS is included in Appendix B. The items which are scored are indicated in appendix. The criteria for a problem gambler was an endorsement of three or four scored items. Five or more scored items was considered indicative of pathological gambling. The third section (questions 85 to 96) captures basic demographic information about the respondents. The fourth section (question 97) measures the respondents awareness of treatment options. The fifth and final section (questions 98 and 99) asks the respondents if they are willing to take part in future studies. Additional questions were added in the second and third surveys to capture gambling activities at the recently opened casino. A copy of the initial survey instrument is included in Appendix C.

Hypotheses

Overall Structure

The primary hypotheses to be evaluated centre on the testing of the applicability of the distribution of consumption model to gambling consumption. Secondary hypotheses address the dose-response relationship and the effect of increased availability.

Primary Hypotheses

Lognormality of Consumption. The principal feature of the distribution of consumption model is the lognormal nature of the distribution of consumption in a population. It is the form of the distribution that gives insight into the underlying dynamics of consumption in a population and leads to its application to public health policy. The principal hypothesis of this analysis is that the distribution of gambling consumption in the Windsor samples will follow the lognormal distribution.

The analysis will be carried out first on the estimated gambling expenditures for the previous year. This is a direct analogue to the measure used in the alcohol research discussed earlier. It is also proposed to carry out the analysis for this hypothesis on percentage of family income expended on gambling. This index of consumption in effect "normalises" the consumption across income levels and removes potential distortions due to income levels. Since many gambling problems are financially related, the measure may be more closely associated with gambling related problems than total expenditures.

It is proposed to test initially for lognormality by taking the natural logarithm of the consumption data and carrying out a conventional test for normality. However, as noted in the review of the literature, because of the large sample sizes, standard statistical analyses may have such high statistical power that the hypothesis of lognormality will be rejected even though the deviations may be quite small. A utility of knowledge approach was proposed as a way of resolving potential problems. In this approach the best fit model would be obtained and the error of prediction calculated and reported. This would allow judgement of the model to be made on the applicability of the model to various situations, such as, public health policy based on the actual utility of the model.

To fit a lognormal distribution, or other distribution if necessary, to the data and to estimate the predictive accuracy it is proposed to take a computational approach consistent with the approach taken by the relatively new "bootstrap" statistical technique (Efron & Tibshirane, 1993). The bootstrap utilizes the extensive computational abilities of computers to generate statistical parameters and tests. In this case it is proposed to utilize the optimization function of Mathcad (Mathsoft, 1997), a program for carrying out mathematical analysis, to estimate the parameters of a lognormal, (or other distribution, if necessary) that best fits the consumption distribution. Once the distribution and its parameters are established the predictive accuracy can then be calculated from the predicted and actual values. The optimization function in Mathcad systematically varies the distribution parameters, mean and standard deviation, until a chosen function is minimized. The function to be minimized would be one that calculated the error of prediction. The approach is conceptually similar to the more familiar formulaic approaches and offers advantages over the conventional approach. It is highly flexible. Programs such as Mathcad contain a wide range of possible mathematical functions whose fit to the data can be evaluated should the lognormal function prove to be a poor fit. The analysis is not confined to minimizing the conventional square of the deviations. Because of the skewedness of the expected lognormal distribution, minimizing the square of the deviation may give excessive weight to the small number of extreme data points in the tail of the distribution. Since the distribution of consumption model is used to predict the number of consumers at various consumption levels, it is proposed to minimize the total or average predictive error. It is proposed to determine the lognormality of each of the overall population samples and to explore the lognormality of sub-populations such as gender, age groups, etc.

Heavy Consumption Varies With Average Consumption. The alcohol literature has shown general support for the relationship between average consumption and the proportion of heavy consumers. It is hypothesised that a similar relationship will exist for gambling consumption. Unlike alcohol, there is no agreement on level of gambling consumption that is considered "heavy" and thus likely to produce gambling related problems. Sub-populations, such as gender, income, age, etc. will be used to test this hypothesis. Although the sub-populations are not strictly independent they should nevertheless provide an adequate test of the basic hypothesis of the relationship between average consumption and the proportion of heavy consumers. It is proposed to use regression analysis, linear or non-linear as required, to assess if a relationship between average consumption and the proportion of "heavy" consumers exists and to determine its form. The analysis will be carried out for the overall estimated gambling expenditures and for the percentage of family income expended on gambling.

Deviations in the Tail of the Distribution. The analysis of the distribution of alcohol consumption has shown deviations from lognormality in the tail of the distribution. These deviations have been attributed to restraining social forces and the negative effects of consuming large quantities of alcohol. It is proposed to test for the presence of such restraining factors and it is hypothesised that gambling, like alcohol, will also be restrained at the higher consumption levels. It is proposed to broaden the analysis and to measure the fit of various consumption ranges to the optimized lognormal function calculated for the entire population. To test this hypothesis it is proposed to calculate the average error of prediction for ten ranges of consumption in increments of 10%, e.g. 0%-10%, 11%-20%, .. and 91%-100%. Differences between the various ranges can be tested using non-parametric tests such the Mann Whitney U test. According to the hypothesis the best fit should occur in the low to moderate consumption levels and gradually worsen in the higher consumption levels.

Secondary Hypotheses

Non-Linear Dose-Response Relationship. Alcohol research has consistently found a non-linear relationship between consumption and alcohol related problems. It is hypothesised that a similar non-linear relationship will exist between gambling consumption and gambling related problems. Both total expenditures on gambling in the last year and the percentage of family income spent on gambling in the last year will be used as measures of gambling consumption. Two measures of problem gambling will be utilized. First, the number of SOGS problem items endorsed will be used as an indicator of overall gambling related problems experienced by individuals in the population. For various consumption ranges the average number of problems experienced will be calculated. Second, an incidence rate of problem gambling and pathological gambling will be calculated for each of the consumption ranges. Regression analysis, both linear and non-linear, will be used to determine the form of the relationship and to determine how much of the variance is explained by the best fitting relationship.

Prevention Paradox. As noted earlier, a public policy that focuses primarily on the alcohol abuser may miss a large number of alcohol related problems that are found in the general population. It is hypothesised that a similar situation exists for gambling related problems, i.e., a significant proportion of gambling related problems can be found among members of the population samples that are not classified as problem or pathological gamblers. It is proposed to calculate the total number of gambling related problems endorsed by all members of the Phase I, II and III samples at various consumption levels. The distribution of total gambling related problems can then be calculated.

Summary

The proposed analysis combined with the unique multi-year data set that tracks gambling behaviour in the Windsor community provides an opportunity to assess the applicability of the distribution of consumption model to gambling behaviour. The proposed analysis will allow the assessment of the basic elements of the distribution of consumption model. The results will enhance the basic understanding of gambling behaviour, and assist in the development of public health policy to minimize gambling related problems.

Results

Sample Characteristics

The three surveys sampled 2682, 2581 and 2714 adults (18 years of age and over) in the Metropolitan Windsor area. The response rates, i.e. the ratio of individuals who agreed to participate in the survey to the number of usable telephone numbers called, was 51%, 75% and 73% respectively. A comparison of sample characteristics and census data is shown in Table 3. From Table 3 one can see that, compared to the census data, the sample has an over-representation of females, an over representation of incomes less than $20,000, an under-representation of incomes over $70,000, an under-representation of over 70 year olds, an under-representation of lower educational levels and an over-representation of University graduates. Similar deviations from the census data are found in other telephone based gambling surveys. For example, Sommers' (1988) survey of Pennsylvania and New Jersey was over-represented in the lower age groups, i.e., less than 50 years old, over represented in the high income ranges and under-represented in low income range, and Volberg's (1993) survey of Washington State was under-represented in young adults, the elderly and those who had never married.

The deviations from the census data are relatively modest and these deviations have left the various demographic categories well populated. As a result these data are well suited to determining the fit of the distribution of consumption model to gambling behaviour.

Table 3

Selected Demographic Characteristics

Characteristic	1991 Census[1]	Phase I	Phase II	Phase III	1996 Census[2]
Gender					
Male	47.9%	40.2%	39.8%	40.3%	47.6%
Female	52.1%	59.8%	60.2%	59.7%	52.4%
Age in Years					
18-19	3.9%	6.0%	4.4%	4.3%	3.3%
20-29	21.4%	24.5%	20.8%	21.9%	21.2%
30-39	21.4%	25.1%	25.1%	22.6%	21.0%
40-49	17.6%	17.2%	18.9%	19.4%	17.5%
50-59	12.6%	11.6%	12.7%	14.2%	12.6%
60-74	16.4%	12.9%	14.3%	13.8%	16.7%
75 & up	6.7%	2.8%	3.8%	3.8%	7.8%
Education					
0 to Grade 8	11.3%	3.8%	3.9%	2.9%	7.7%
Some High School	23.1%	14.7%	11.8%	10.1%	17.8%
High School Grad.	18.1%	29.8%	32.8%	28.5%	14.2%
Some Community College	6.3%	10.7%	8.1%	8.7%	22.8%
Community College Grad.	13.1%	10.9%	13.4%	15.8%	12.3%
Some University	15.1%	12.3%	9.5%	10.1%	12.5%
University Grad.	13.1%	17.7%	20.5%	21.9%	12.7%
Family Income (in $1,000)					
Under $20	14.2%	23.7%	20.5%	14.5%	16.0%
$20 to $29	11.3%	14.8%	15.6%	9.7%	12.3%
$30 to $39	13.2%	14.0%	14.2%	11.2%	10.8%
$40 to $49	14.7%	13.3%	13.0%	12.1%	11.4%
$50 to $59	13.2%	11.3%	12.7%	10.3%	10.7%
$60 to $69	10.6%	6.8%	7.8%	8.3%	9.7%
$70 and up	22.8%	16.2%	16.2%	33.8%	29.2%

1 - (Statistics Canada, 1994a);(Statistics Canada, 1994b)

2 - (Statistics Canada, 1999)

The Lognormality of Gambling Consumption

Gambling Consumption Measured in Dollars

Survey respondents were asked to estimate their total gambling expenditures in dollars for the previous year. The general properties of these estimated gambling expenditures are given in Table 4.

Table 4
Descriptive Statistics for Gambling Consumption by Phase in Dollars

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I	565	150	1688	9.6	1	30,000	3.48%
Phase II	664	200	3391	14.6	2	75,000	5.20%
Phase III	692	150	3907	20.0	1	100,000	2.08%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

The properties of the phase 1, 2 & 3 distribution of gambling consumption are consistent with the distribution of consumption model, i.e., as the mean increases the standard deviation and skewness similarly increase.

Histograms showing the shape of the distribution of estimated annual gambling consumption for phase 1 are shown in Figures 13 and 14. Please note the change in scale on the X-axis between the two graphs. Two histograms were required because of the highly skewed nature of the consumption data. The distribution shows the typical highly skewed shape of the lognormal distribution. The distributions for phase 2 and 3 have similar shapes. Utilizing the Kruskal-Wallis one-way analysis of variance by ranks (Siegel, 1956), a non-parametric test that determines if a set of independent samples are from the same distribution. The results show that there is no statistically significant difference between the phase 1, 2 & 3 samples, $\chi^2(2, \underline{N}=5,144) = 1.46$, p=0.48. To test for lognormality a natural logarithmic transformation was applied to the phase 1 estimated annual gambling expenditures. A normal probability-probability plot of the transformed data is shown in Figure 15. The fit is similar to that noted previously for the alcohol literature, i.e., the distribution makes a generally good fit to the expected distribution but there are deviations. Some of these deviations are due to the natural tendency of respondents to round off their answers, e.g., $200 rather than an estimate of $184. Testing for normality utilizing the Kolmogorov-Smirnov test with a Lilliefors statistic showed that the differences from normality are statistically significant, Lilliefors(1581)=0.072, p<.0001. As with the distribution of alcohol consumption the large N makes the modest deviations statistically significant. A two stage process was carried out to provide a measure of how close the data is to a lognormal distribution. First, Mathcad was utilized to estimate the parameters of a lognormal distribution that best fit the data. In this case a best fit was defined as the values of the distribution parameters that minimized the sum of the absolute values of the deviations. The square of the deviations was not utilized because there is no reason to strongly emphasize points with larger deviations. Once the parameters of a lognormal distribution that best fit the data were estimated, Mathcad was utilized to determine the average deviation from this ideal curve. In this manner an estimate of the average error of prediction could be made. Appendix A shows the Mathcad worksheet for the phase 1 data.

Figure 13

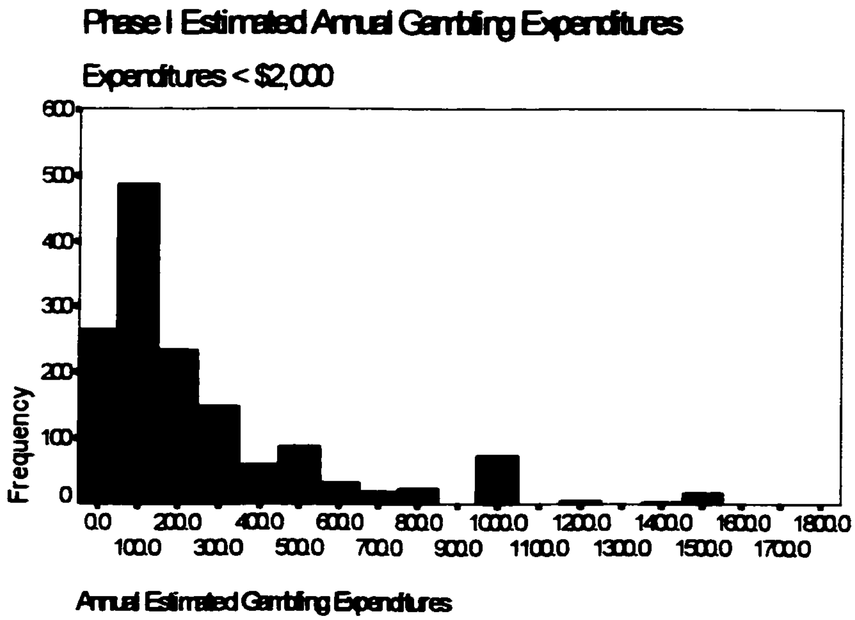
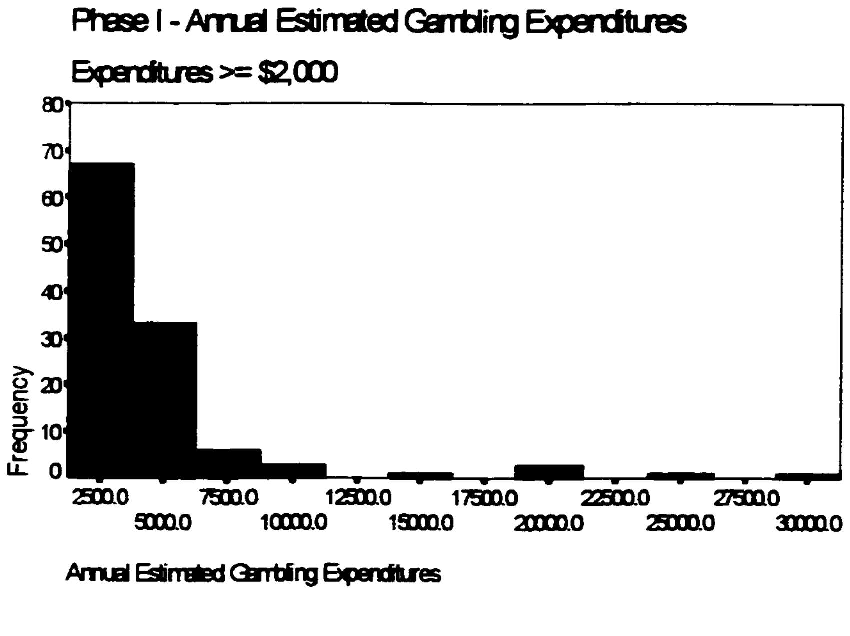


Figure 14



In this case the average deviation between the cumulative probability estimated by the theoretical curve and the cumulative probability of the data was 0.017. If the 0-1 probability scale is converted to a percentage scale, i.e., 0%-100%, the error is equivalent to 3.4 percentage points at the median or 50th percentile point. Sub-population characteristics are shown in Tables 5 to 8.

Figure 15

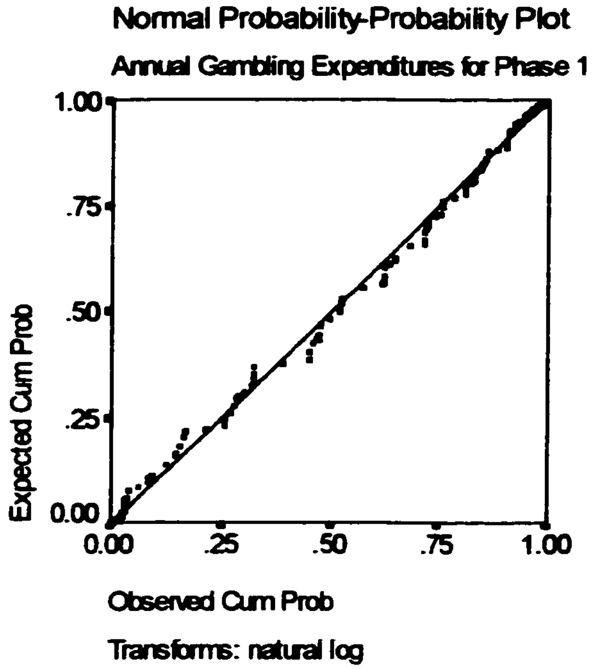


Table 5

Descriptive Statistics for Gambling Consumption by Phase and Gender, in Dollars

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
Female	367	100	961	7.8	1	15,000	3.58%
Male	801	200	2,276	7.9	1	30,000	3.82%
Phase II							
Female	358	120	979	8.4	2	14,400	5.10%
Male	1,059	250	4,982	10.2	2	75,000	5.98%
Phase III							
Female	433	100	1,245	7.6	1	20,000	3.46%
Male	1,045	200	5,814	14.1	1	100,000	3.40%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Table 6

Descriptive Statistics for Gambling Consumption by Phase and Age Subgroups, in Dollars

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
18-29	439	100	1,334	8.5	1	20,000	4.68%
30-39	559	200	1,391	8.2	5	20,000	2.54%
40-49	866	200	2,739	7.8	1	30,000	3.96%
50 & up	535	200	1,405	9.0	1	20.000	2.84%
Phase II							
18-29	668	150	4,616	14.3	2	75,000	4.64%
30-39	827	200	3,712	10.5	2	55,000	5.58%
40-49	582	200	2,120	10.5	2	30,000	5.92%
50 & up	560	200	2,100	10.1	2	30,000	5.70%
Phase III							
18-29	680	120	3,453	16.0	2	70,000	3.74%
30-39	497	150	1,331	8.9	1	20,000	3.52%
40-49	1,104	188	7,063	13.3	1	100,000	3.18%
50 & up	573	150	2,344	16.2	1	50,000	2.82%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Table 7

Descriptive Statistics for Gambling Consumption by Phase and Religious Group Membership, in Dollars

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
Member of a Religious Group							
Yes	493	125	1,614	11.7	1	30,000	3.58%
No	636	200	1,759	8.0	1	25,000	3.44%
Phase II							
Member of a Religious Group							
Yes	548	150	3,140	18.7	2	75,000	5.86%
No	812	200	3,699	11.3	2	55,000	4.74%
Phase III							
Member of a Religious Group							
Yes	549	120	2,898	18.0	1	70,000	3.02%
No	867	200	4,841	18.3	1	100,000	3.28%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Table 8

Descriptive Statistics for Gambling Consumption by Phase and Family Income, in Thousands of Dollars

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
< 20	394	105	842	4.6	1	6,000	3.64%
20 - 39	451	150	874	4.1	1	7,000	4.32%
40 - 69	453	150	925	4.6	4	7,500	3.46%
70 & up	1,236	200	3,466	5.4	3	30,000	4.08%
Phase II							
< 20	478	120	1,695	9.2	5	20,000	4.20%
20 - 39	596	150	3,265	14.8	2	55,000	5.66%
40 - 69	604	200	2,366	10.8	2	30,000	6.16%
70 & up	622	250	2,203	9.3	5	25,000	6.88%
Phase III							
< 20	337	100	1,005	7.5	2	10,000	3.38%
20 - 39	557	120	1,368	5.8	1	14,000	3.82%
40 - 69	993	150	5,994	14.0	2	100,000	3.22%
70 & up	652	200	1,791	7.0	1	20,000	3.08%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

The Kruskal-Wallis One-Way Anova, a non-parametric test of group differences, was utilized to determine if the group differences shown in Tables 5 to 8 were statistically significant because of the highly skewed nature of the underlying distributions. The results are summarized in Table 9.

Table 9

Statistical Significance of Group Differences[1]

Group	Phase	Significance
All Gamblers		
	1, 2, & 3	N.S.[2]
Age Ranges		
	1	$p<.001$
	2	N.S.
	3	N.S.

Table 9 (Continued)

Statistical Significance of Group Differences[1]

Group	Phase	Significance
Family Income Ranges		
	1	p<.001
	2	p=.006
	3	p<.001
Gender		
	1	p<.001
	2	p<.001
	3	p<.001
Religious Group Membership		
	1	p=.005
	2	p=.006
	3	p<.001

[1] Kruskal-Wallis One-Way Anova

[2] N.S. Not Statistically Significant

Gambling Consumption Measured in Terms of Percentage of Family Income

Although the estimated annual gambling expenditures generally follow the distribution of consumption model, it is of considerable interest to test how well gambling expenditures, expressed as a percentage of family income, fit the distribution of consumption model. The normalization of consumption data in this manner would be expected to more accurately reflect the financial impact of gambling on an individual and would address the potential criticism, that the skewed distribution of gambling expenditures simply reflects the skewed distribution of incomes in a population. Family income was collected from respondents in terms of income ranges, because individuals are generally reluctant to provide income information. The mid-point of these ranges was used as an estimate of family income and the end points were extrapolated graphically. Despite the use of income ranges, the refusal rate for this question was approximately 30%. This reluctance to discuss income data is a long standing survey problem. For example, the authors of a study of women's use of family planning practices in the 1950s found that, to their surprise, some respondents found income questions more personal than those related to their sexual practices (Freedman, Whelpton & Campbell, 1959 as cited in Rainwater, 1960). The family income data provides an adequate basis for testing the distribution of consumption model for two reasons. First, as shown in Table 3 the income data is a reasonable approximation of the income distribution in the population as measured by census data. Second, the survey sample contains 3,612 gamblers who have provided income data, a more than adequate number to test the distribution of consumption model.

The general properties of the percentage of family income spent on gambling, for phases 1, 2 & 3, are given in Table 10. As with the estimated gambling expenditures we find that the distributions of percentage of family income spent on gambling is highly skewed, with skewness values ranging from 7.19 to 15.92.

Table 10

Descriptive Statistics for Percentage of Family Income Spent on Gambling

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I	1.78%	0.44%	4.73	7.19	.0033%	60%	1.62%
Phase II	1.99%	0.46%	9.53	14.54	.0031	200%	2.00%
Phase III	1.61%	0.30%	7.38	15.92	.0007$	182%	1.36%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Histograms showing the general shape of the distribution for phase 1 are shown in Figures 16 and 17. Two histograms were required because of the skewed nature of the distribution. The distributions for the other phases are similar. A Kruskal-Wallis One-Way analysis of variance by ranks shows that the distributions from phase 1, 2 and 3 differ significantly, X2(2, N=3612) = 40.73, p<.0001. To test for lognormality a natural logarithmic transformation was applied to the percentage of income spent on gambling. Probability-probability plots provide a visual measure of the goodness of fit. The probability-probability plot for phase 1 is shown in Figure 18.

Figure 16

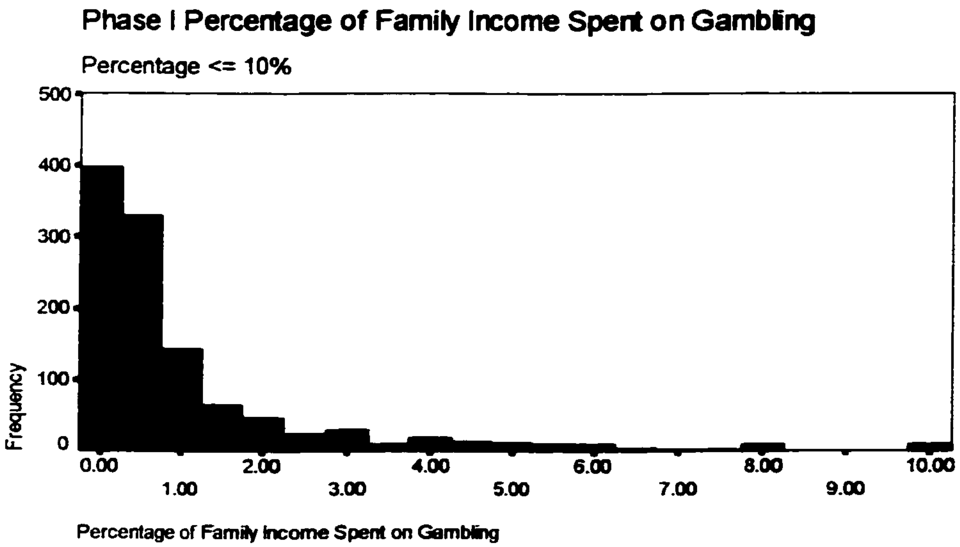


Figure 17

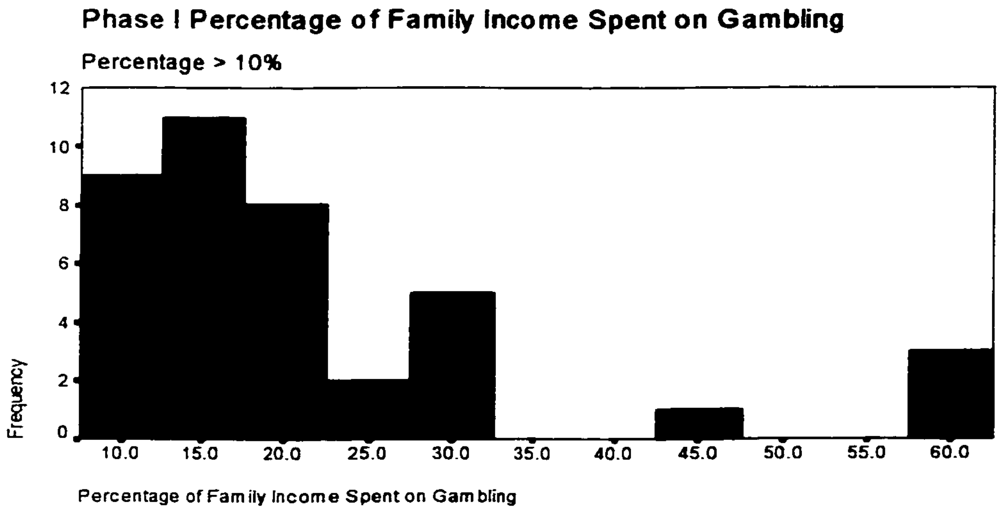
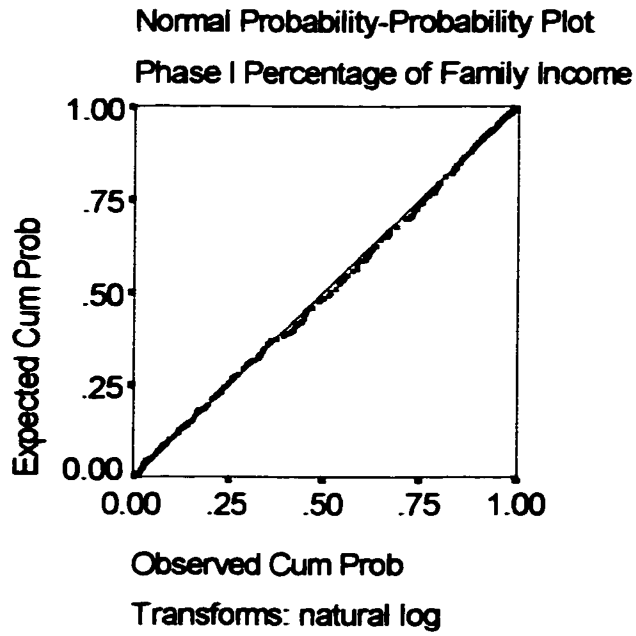


Figure 18



Visually the data are a good fit to a lognormal distribution. The Kolmogorov-Smirnov test with a Lilliefors statistic shows that the deviations from normality are statistically significant, Lilliefors(1173)=0.0318, p=0.0073. As with the distribution of alcohol consumption the large N makes the modest deviations statistically significant. The average error in fitting the data to a lognormal distribution was calculated in the same manner as for the distribution of consumption expressed in dollars. **The results for the other sub-groups are summarized in Tables 11 to 14.**

Table 11

Descriptive Statistics for Percentage of Family Income Spent on Gambling by Phase and Age Subgroups

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
18-29	1.80%	0.44%	4.80	6.83	.0053%	60.0%	2.90%
30-39	1.55%	0.40%	4.34	9.11	.0033%	60.0%	2.02%
40-49	1.88%	0.36%	5.50	7.13	.0033%	60.0%	2.40%
50 & up	1.95%	0.55	4.39	5.43	.0040%	42.5%	1.61%
Phase II							
18-29	1.47%	0.50%	3.01	5.07	.0143%	30.0%	2.56%
30-39	3.29%	0.43%	16.90	9.00	.0036%	200.0%	3.58%
40-49	1.16%	0.39%	3.80	10.55	.0031%	50.0%	3.14%
50 & up	1.77%	0.56%	4.92	7.29	.0080%	54.6%	2.44%
Phase III							
18-29	2.17%	0.34%	9.36	9.15	.0044%	107.7%	1.93%
30-39	1.06%	0.29%	2.75	6.63	.0007%	30.8%	1.58%
40-49	1.78%	0.24%	10.67	15.74	.0007%	181.8%	2.00%
50 & up	1.46%	0.33%	4.17	8.70	.0013%	56.0%	1.65%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Table 12

Descriptive Statistics for Percentage of Family Income Spent on Gambling by Phase and Gender

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
Female	1.40%	0.34%	3.90	8.34	.0033%	60.0%	1.95%
Male	2.21%	0.60%	5.50	6.35	.0053%	60.0%	1.78%
Phase II							
Female	1.51%	0.40%	5.42	12.58	.0036%	100.0%	1.89%
Male	2.58%	0.55%	12.90	11.88	.0031%	200.0%	3.46%
Phase III							
Female	1.31%	0.23%	4.87	13.49	.0007%	100.0%	3.54%
Male	1.98%	0.44%	9.56	13.95	.0007%	181.8%	2.24%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Table 13

Descriptive Statistics for Percentage of Family Income Spent on Gambling by Phase and Religious Group Membership

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
Member of a Religious Group							
Yes	1.42%	0.33%	4.45	9.31	.0033%	60.0%	2.04%
No	2.12%	0.57%	4.96	5.75	.0033%	60.0%	1.90%
Phase II							
Member of a Religious Group							
Yes	1.26%	0.40%	4.26	9.01	.0036%	54.5%	2.54%
No	2.80%	0.55%	13.14	11.38	.0031%	200.0%	2.40%
Phase III							
Member of a Religious Group							
Yes	1.33%	0.25%	6.50	13.33	.0007%	107.7%	1.75%
No	1.92%	0.40%	8.23	16.84	.0012%	181.8%	1.29%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

Table 14

Descriptive Statistics for Gambling Consumption by Phase and Family Income, in Thousands of Dollars

	Mean	Median	Std. Dev.	Skewness	Min	Max	Average Error[1]
Phase I							
< 20	3.94%	1.05%	8.42	4.60	.0100%	60.0%	3.64%
20 - 39	1.53%	0.43%	3.07	4.39	.0040%	28.0%	4.10%
40 - 69	0.87%	0.31%	1.81	4.79	.0089%	16.7%	2.04%
70 & up	1.19%	0.23%	3.36	5.27	.0033%	26.7%	3.24%
Phase II							
< 20	4.78%	1.20%	16.95	9.16	.0500%	200.0%	4.20%
20 - 39	1.98%	0.57%	9.79	13.33	.0080%	157.1%	4.32%
40 - 69	1.11%	0.36%	4.07	10.32	.0031%	54.5%	5.12%
70 & up	0.73%	0.22%	2.93	9.51	.0056%	33.3%	3.22%
Phase III							
< 20	3.37%	1.00%	10.05	7.49	.0200%	100.0%	3.38%
20 - 39	1.87%	0.40%	4.99	6.96	.0029%	56.0%	3.14%
40 - 69	1.80%	0.29%	10.40	14.46	.0044%	181.8%	2.20%
70 & up	0.62%	0.17%	1.76	7.20	.0007%	21.2%	2.34%

[1] Average error in fitting the data to a lognormal distribution measured at the median point of the distribution

The Kruskal-Wallus One-Way Anova, a non-parametric test of group differences, was utilized to determine if the group differences shown in Tables 11 to 14 were statistically significant. The results are shown in Table 15.

Table 15

Statistical Significance of Group Differences[1]

Group	Phase	Significance
All Gamblers		
	1, 2, & 3	p<.0001
Age Ranges		
	1	p=.2058(N.S.)[2]
	2	P<.0052
	3	p<.0354
Family Income Ranges		
	1	p<.0001
	2	p<.0001
	3	p<.0001
Gender		
	1	p<.0001
	2	p=.0069
	3	p<.0001
Religious Group Membership		
	1	p<.0001
	2	p<.0001
	3	p<.0001

[1] Kruskal-Wallis One-Way Anova

[2] N.S. Not Statistically Significant

To determine how well the lognormal distribution fits the various regions of the distribution, the average error by percentile range for the phase 1, 2 and 3 data were calculated. The results are shown in Table 16. Because the average errors in the lower five percentile ranges appear to be lower than the errors in the upper five percentile ranges, the differences between these groups was tested with a two-tailed Mann-Whitney U test and no statistically significant difference was found between the groups (N_1=5, N_2=5, U=5: p=.075).

Table 16
Average Model Error[1] by Percentile Range for Percentage of Family Income Spent on Gambling

	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	Average Error[1]
Phase I	0.64	0.75	1.63	1.33	2.32	2.00	1.01	1.10	2.94	2.40	1.61
Phase II	1.26	0.97	1.22	1.35	2.72	2.92	1.47	4.10	2.20	1.73	2.00
Phase III	0.94	2.76	0.90	0.71	1.28	1.69	0.96	0.68	1.75	1.96	1.36
Average	0.95	1.49	1.25	1.13	2.11	2.20	1.15	1.96	2.30	2.03	1.66

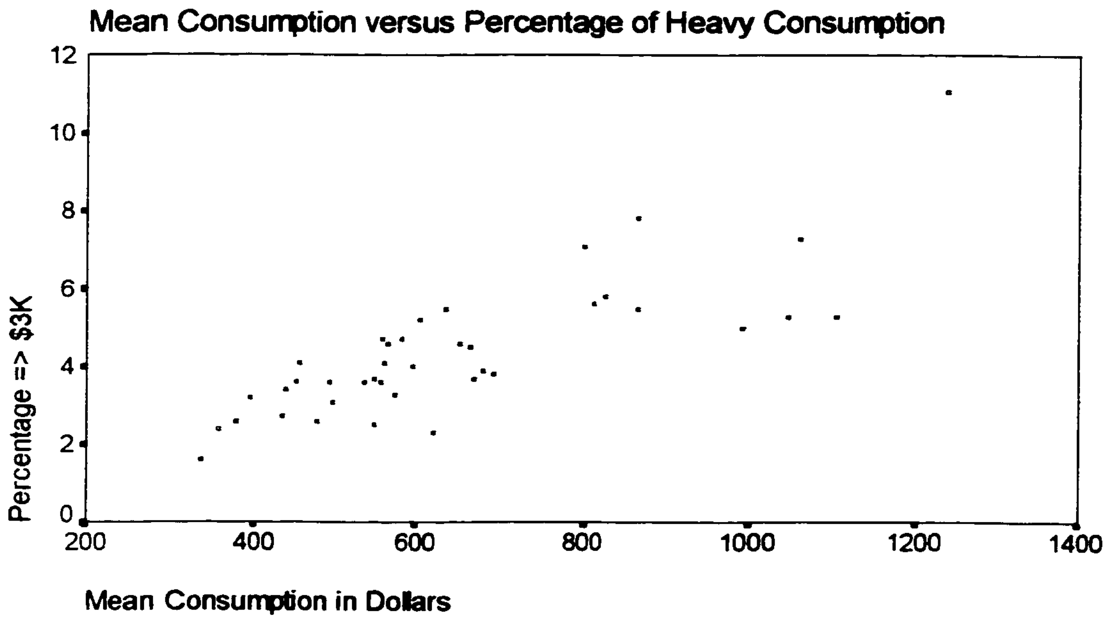
[1] Average percentage error calculated at the median point of the distribution

The Relationship Between Average Consumption and the Percentage of Heavy Users

Gambling Consumption Measured in Dollars

A prediction of the distribution of consumption model is that there is a relationship between mean consumption in a population and the percentage of heavy consumers. For this analysis heavy consumption was set as annual gambling expenditures of $3,000 or more. Figure 19 shows a scatter plot of the overall relationship between mean consumption and the percentage of heavy consumers. Clearly there is an overall general trend of increasing percentage of heavy

Figure 19



consumers with increasing mean consumption in the population sub-groups. Five regression models (linear, quadratic, cubic, power, and exponential) were fitted to the data. The explained variance, as measured by an adjusted R^2 for each model is shown in Table 17. Analysis of variance for each model has shown that all models are highly significant, $p<.0001$ for all models.

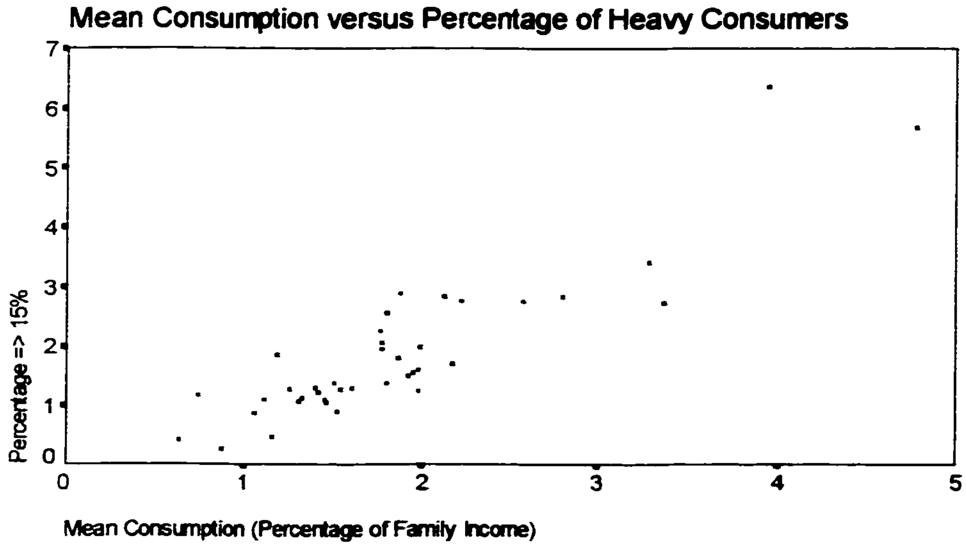
Table 17

Explained Variance of Regression Models - Mean Consumption versus Percentage of Heavy Consumers

Model	Adjusted R^2	Significance of R
Linear	0.656	$p<.0001$
Quadratic	0.649	$p<.0001$
Cubic	0.677	$p<.0001$
Power	0.663	$p<.0001$
Exponential	0.632	$p<.0001$

All five models have very similar levels of explained variance. The linear model is considered the most likely fit for two reasons. First, it is the simplest and, as a general, rule the simplest model that adequately explains the data is the preferred model (Gardner, 1979). Second, although higher order models can potentially yield a better fit to the data, their behaviour when extrapolated to

Figure 20



higher or lower values than found in the model can be problematic. For example, an N^{th} order equation can be made to fit all N points of a data set, however an N^{th} order equation is quite unlikely to be either an adequate descriptor of another similar data set or to behave in a reasonable manner outside of the range of data on which the model was built. This choice is supported by a visual examination of Figure 19 which shows no obvious non-linear trend in the data.

Gambling Consumption Measured as a Percentage of Family Income

The above analysis was repeated using the percentage of family income spent on gambling as a measure of consumption. Heavy consumption was set at 15% of family income. Figure 20 shows the scatter plot demonstrating the overall relationship between mean consumption in a sub-population and the percentage of heavy consumers. There is a clear overall trend of an increasing percentage of heavy consumers with increased mean consumption. Five regression models (linear, quadratic, cubic, power and exponential) were fitted to the data. The explained variance as measured by the adjusted R^2 statistic for each model is shown in Table 18.

Analysis of variance has shown each model to be statistically significant at the $p<.0001$ level.

Table 18

Explained Variance of Regression Models - Mean Consumption versus Percentage of Heavy Consumers

Model	Adjusted R^2	Significance of R
Linear	0.804	$p<.0001$
Quadratic	0.802	$p<.0001$
Cubic	0.805	$p<.0001$
Power	0.725	$p<.0001$
Exponential	0.677	$p<.0001$

Given the overall similarity of the explained variance of the linear, quadratic and cubic models, the simplest of the choices, i.e. the linear model is most likely the "best" fit. This choice is supported by a visual examination of Figure 20 which shows no obvious non-linear trend in the data.

Dose-Response Relationship

Gambling Consumption Measured in Dollars

The link between the distribution of gambling consumption and gambling related problems in a populations is indicated by the dose-response relationship. It is assumed that there is a relationship between the increasing levels of consumption and the number of gambling related problems experienced by individuals. Such a relationship might well be expected to have a threshold level, i.e. a level of consumption below which no harm is likely to occur. Figure 21 shows a plot of number of SOGS problem items endorsed in the last year versus estimated annual gambling expenditures for those who gambled. Visually there does not appear to be an obvious relationship between amount gambled and the previous year's SOGS score. Table 19 shows the results of fitting various regression models to the data of Figure 21. The slightly larger explained variance, as compared to the linear model, of the quadratic, cubic, power and exponent models, suggests that there is an increasing rate of endorsed problems with increased expenditures. However, the similarity of the various models in terms of explained variance leaves open the nature of this non-linearity. In any case the relationship between consumption and total SOGS score is weak.

Figure 21

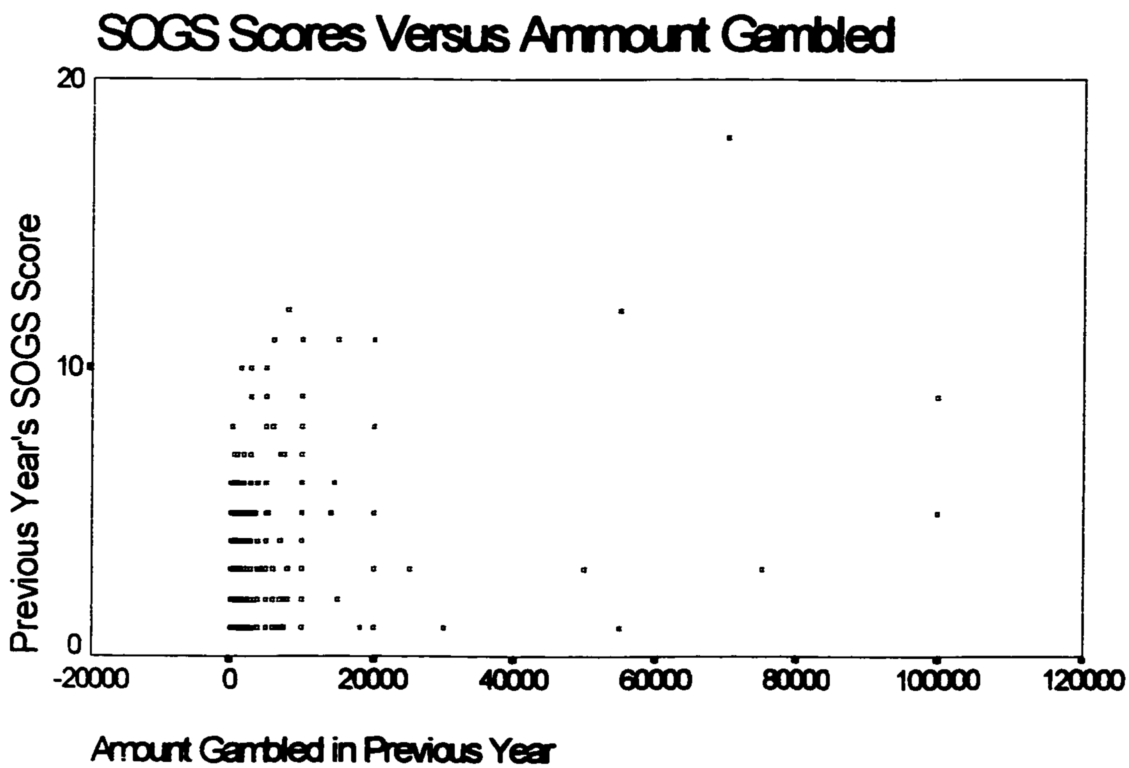

SOGS Scores Versus Ammount Gambled
20
10
0
Previous Year's SOGS Score
-20000
0
20000
40000
60000
80000
100000
120000
Amount Gambled in Previous Year

Table 19

Regression Models for Previous Year's SOGS Scores and Annual Gambling Expenditure

Model	Adjusted R^2	Significance of R^2
Linear	0.14	$p<0.0001$
Logarithmic	0.08	$p<0.0001$
Quadratic	0.19	$p<0.0001$
Cubic	0.20	$p<0.0001$
Power	0.17	$p<0.0001$
Exponent	0.18	$p<0.0001$

An alternate approach is to calculate the risk of being a problem or pathological gambler for various expenditure ranges. These risk values are given in Table 20.

Table 20

Risk for Problem and Pathological Gambling by Gambling Expenditure Range for Phase 1, 2 and 3, for Gamblers

Annual Gambling Expenditure	N	Problem Gambling		Pathological Gambling	
		Rate	N	Rate	N
\$1 - \$249	3 ,137	0.7%	22	0.1%	7
\$250 - \$499	825	1.9%	16	0.4%	3
\$500 - \$999	541	3.5%	19	1.1%	6
\$1,000 - \$1,999	295	6.8%	20	3.4%	10
\$2,000 - \$4,999	235	7.7%	18	11.5%	27
\$5,000 - \$9,999	64	10.9%	7	23.4%	15
\$10,000 - up	47	14.9%	7	38.3%	18

Figure 22 shows the relationship between the risk of pathological gambling and average gambling expenditure. Since the increase in risk appears to be decelerating with increased consumption the following regression models were fitted to the data, linear, logarithmic, inverse, compound, power and exponent. The results are shown in Table 21.

Figure 22

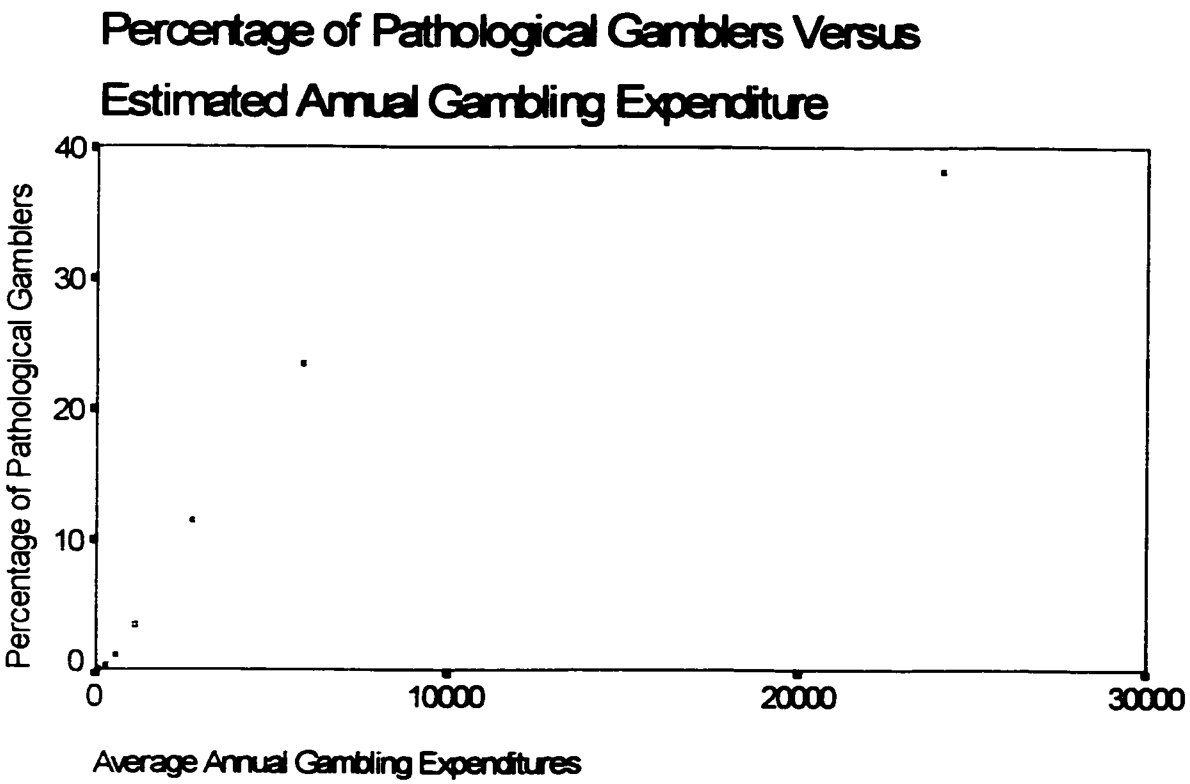


Table 21

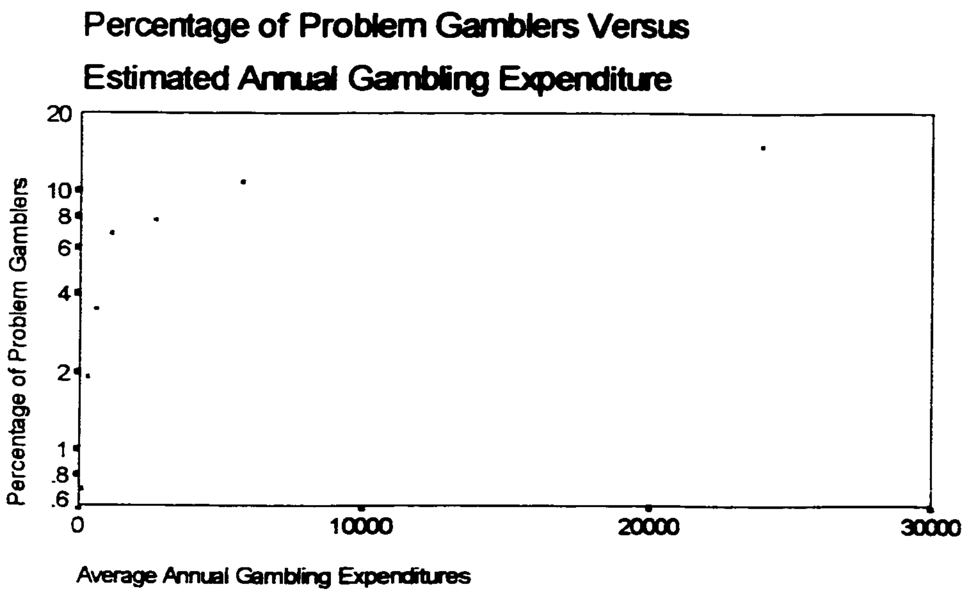
Regression Models for Percentage of Pathological Gambling and Estimated Annual Gambling Expenditure

Model	Adjusted R^2	Significance of Adjusted R^2
Linear	0.83	p=0.0026
Logarithmic	0.81	P=0.0034
Inverse	0.11	P=0.2469
Compound	0.34	P=0.0973
Power	0.95	P=0.0002
Exponent	0.34	P=0.0973

The best fit is provided by a power function, however the exponent is only slightly larger than one (1.145).

Figure 23 shows the relationship between the percentage of problem gambling and the estimated annual gambling expenditure. Based on the shape of the curve the following regression models were fitted to the data, linear, logarithmic, power and exponent. The models are summarized in Table 22. The best fit is provided by the logarithmic function. Interestingly the exponent in the power function is 0.55, suggesting that the risk varies approximately as the square

Figure 23



root of consumption.

Table 22

Regression Models for Percentage of Problem Gambling and Estimated Annual Gambling Expenditures

Model	Adjusted R^2	Significance of Adjusted R^2
Linear	0.65	P=0.0170
Logarithmic	0.96	P=0.0001
Power	0.89	P=0.0008
Exponent	0.27	P=0.1330

Gambling Consumption Measured as a Percentage of Family Income

The link between gambling consumption levels and problem gambling was further explored utilizing the normalized consumption data. Figure 24 shows a plot of the number of SOGS item endorsed versus the percentage of family income spent on gambling in the previous year. As with the relationship between the dollars spent on gambling and the previous year's SOGS scores, the relationship does not appear to have a threshold value. Various regression models were fitted to the data in Figure 24 and the results are shown in Table 23. Three models provided very similar levels of explained variance, the linear, quadratic and cubic models. On the basis of simplicity and stability when extrapolated to other data sets the linear model is likely the best model to describe the data.

Figure 24

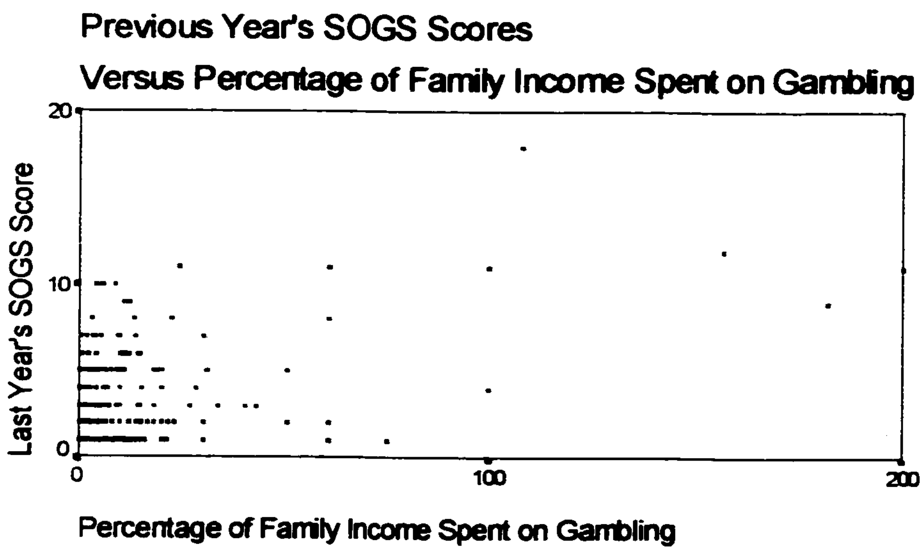


Table 23

Regression Models for Previous Year's SOGS Scores and Percentage of Family Income Spent on Gambling

Model	Adjusted R^2	Significance of R^2
Linear	0.26	$p<0.0001$
Quadratic	0.28	$p<0.0001$
Cubic	0.28	$p<0.0001$
Power	0.17	$p<0.0001$
Exponent	0.15	$p<0.0001$

As an alternate approach to measuring the dose-response relationship, the risk of becoming a problem or pathological gambler was calculated for various consumption levels. These risk levels for the total sample and the various sub-groups are given in Table 24.

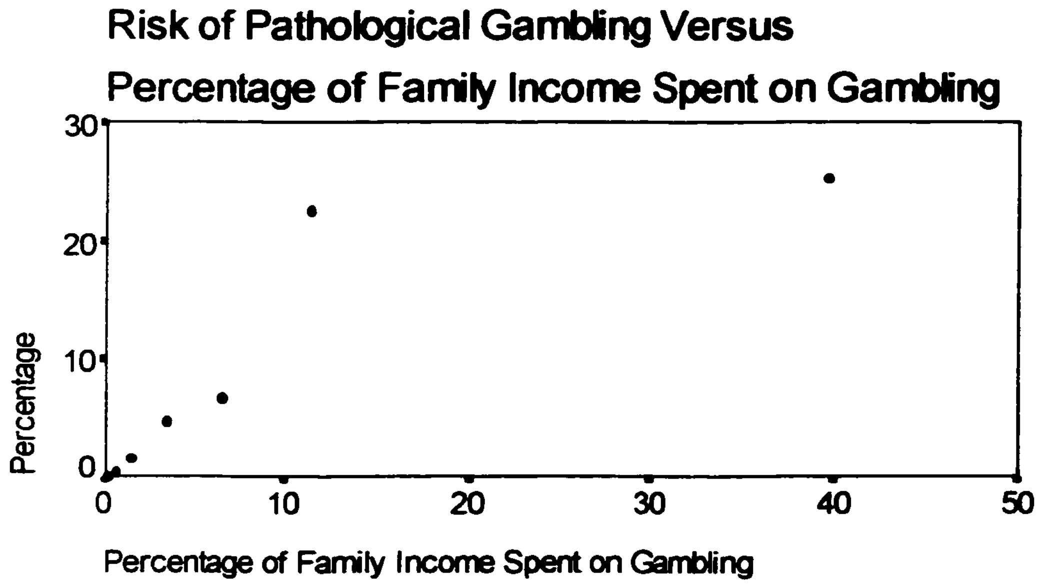
Table 24

Risk for the Development of Problem and Pathological Gambling by Consumption Ranges for Phases 1, 2 and 3.

	Percentage of Family Income Spent on Gambling						
	0-.5%	.5-1%	1-2.5%	2.5-5%	5-10%	10-15%	15%-up
Problem gambling	.007	.019	.022	.057	.068	.113	.143
Pathological gambling	.001	.005	.016	.048	.068	.226	.254

The results of Table 24 are shown graphically in Figures 25 and 26. As with consumption

Figure 25



expressed in terms of dollars, various regression models were fitted to the data and the results are shown in Tables 25 and 26. In both cases a power function provides the best fit to the data. For the risk of pathological gambling the exponent of the power function is just slightly greater than one (1.1). For the risk of problem gambling the exponent is 0.59, suggesting that the risk varies approximately with the square root of consumption.

Table 25

Regression Models for Percentage of Pathological Gambling and Percentage of Family Income Spent on Gambling

Model	Adjusted R^2	Significance of Adjusted R^2
Linear	0.68	P=0.0141
Logarithmic	0.71	P=0.0103
Power	0.95	P=0.0001
Exponent	0.34	P=0.0970

Figure 26

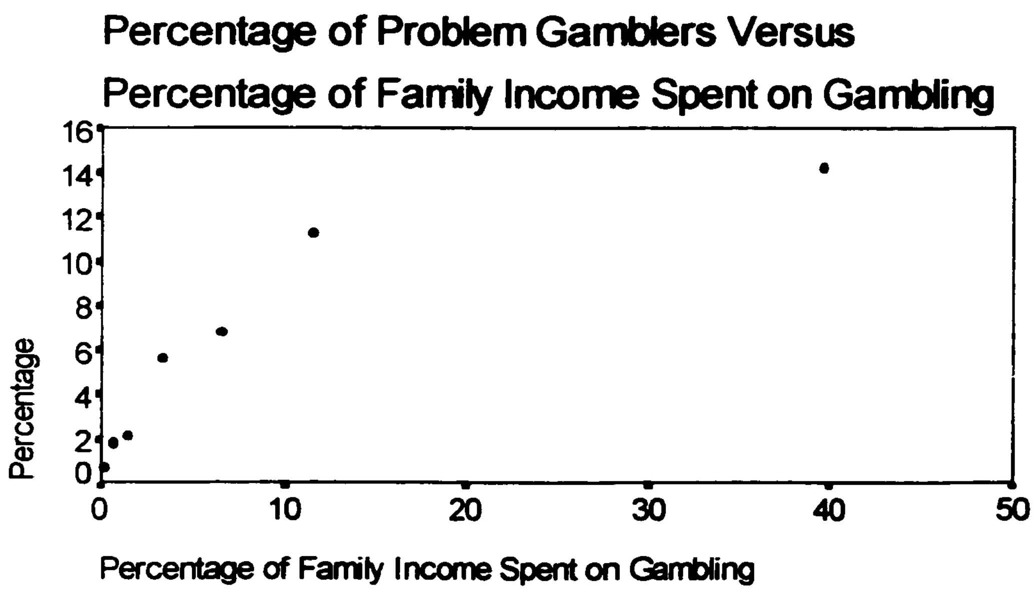


Table 26

Regression Models for Percentage of Problem Gambling and Percentage of Family Income Spent on Gambling

Model	Adjusted R^2	Significance of Adjusted R^2
Linear	0.71	P=0.0105
Logarithmic	0.88	P=0.0010
Power	0.96	P=0.0001
Exponent	0.39	P=0.0783

The Prevention Paradox

Although the risk of becoming a problem or pathological gambler clearly increases with increased consumption this does not necessarily imply that most of the gambling related problems in a population will be primarily among the high consumers in that population. The lognormal distribution of consumption implies that there will be relatively few heavy consumers and a large number of light to moderate consumers in a population. The distribution of gambling problems in a population is thus an interaction between the lognormal distribution of consumption and the risk of developing gambling related problems. A gambler's SOGS score was used as a measure of gambling related problems. Table 27 shows the total number of gambling related problems endorsed by individuals in the various consumption ranges.

Table 27

Total Number of SOGS Problem Items Endorsed by Consumption Range

Consumption Range	Number of Problem Items Endorsed	Percentage	Number of Gamblers
0.0 - 0.5%	259	18.6%	1,989
0.5 - 1.0%	185	13.4%	588
1.0 - 2.5%	261	18.7%	549
2.5 - 5.0%	197	14.3%	229
5.0 - 10.0%	145	10.4%	132
10.0 - 15.0%	143	10.3%	62
15.0% & up	204	14.6%	63
Total	1,394		3612

Discussion

This study has set out to evaluate the applicability of the distribution of consumption theory of alcohol consumption to gambling consumption. The theory originated with the work of the French demographer Sully Ledermann, who after an extensive mathematical study of alcohol consumption in France, made two key insightful observations: first that the distribution of alcohol consumption was highly skewed to the right and took the form of the lognormal distribution, and second, that as the mean consumption of alcohol in a population increased the percentage of heavy consumers increased as a power function of average consumption (Ledermann, 1956). The highly skewed lognormal distribution reflected the fact that in a population a small percentage of those who consume alcohol consume many times the average population level. Since the development of alcohol related problems was considered a function of the level of alcohol consumption, these heavy consuming individuals were considered at risk for developing alcoholism. The finding of a dramatic increase in the proportion of heavy consumers caused particular concern because it suggested that the increases in postwar alcohol consumption could lead to significant increases in alcoholism. Such concerns led to calls for the restriction of the availability of alcohol (Bruun et al., 1975). Skog advanced the distribution of consumption theory by providing a theoretical basis for the theory and by demonstrating the importance of social factors in determining the parameters of the lognormal distribution in a population (Skog, 1977; Skog, 1985b). The presence of cultural differences suggested that prevention programs that helped establish new societal norms could be effective in reducing alcohol related problems. Prevention programs are considered to be an important factor in the reduction in alcohol consumption and alcohol related problems in Canada and the United States (Smart & Mann, 1995).

The present study has attempted to systematically test the applicability of the distribution of consumption model to gambling by evaluating each aspect of the model on gambling consumption data from the multi-year Windsor gambling prevalence study. The following sections will discuss the support found for the model, the implications of the findings, the study limitations and suggestions for further research.

Support for the Applicability of the Distribution of Consumption Model

The Lognormality of Gambling Consumption

The fundamental premise that underlies the distribution of consumption model is Ledermann's assertion that the consumption of alcohol in a population is lognormally distributed (Ledermann, 1956), making the lognormality of gambling consumption data a key test of the model. For the Windsor samples, the gambling consumption data, expressed either in dollars or in percentage of family income, provides a good fit to the lognormal distribution. This can be seen visually in the probability-probability plots which show only small and non-systematic deviations from normality and in the average error in fitting the data to a lognormal distribution. The average error in fitting the data to a lognormal distribution for the various subgroups was 4.14% for gambling expenditures measured in dollars and 2.58% for gambling expenditures measured in percentage of family income. An analysis of the average error by percentile range showed no systematic deviations from lognormality across the consumption ranges. Taken collectively the evidence suggests that the lognormal distribution is a very good descriptor of gambling consumption in the Windsor samples. It should be noted that participants were asked to estimate their annual gambling consumption. Such estimates are likely to reflect biases in memory and must be considered approximations to the actual levels of gambling expenditures. Since the lognormality is determined by the relative frequency of various levels of gambling consumption rather than the absolute value of gambling consumption, the data can provide a reasonable test of the lognormality of gambling consumption in the Windsor sample.

Unlike alcohol, the distribution of gambling consumption in these samples does not fall significantly below the theoretical distribution at the high consumption end (Table 16). This is likely due to the fact that the possible range of gambling consumption, although finite, is much larger than that of alcohol, which is limited by its negative physical effects. As a result, the gambling consumption data appears to fit the theoretical lognormal distribution better than alcohol consumption data.

Average Consumption Versus Percentage of Heavy Consumers

The second key item proposed by Ledermann (1956) was that as the average consumption in a population increased so did the percentage of heavy consumers in that population. The Windsor sample has shown a strong relationship between the average level of gambling consumption in a sub-population and the percentage of heavy consumers. Since the explained variance for linear and non-linear models was essentially the same the linear model was chosen as the most likely model on the basis of simplicity. Although the choice of a linear model is the most conservative approach, the similarity of the various regression models suggests that the form of the relationship between average gambling consumption and the percentage of heavy consumers will only be determined by examining data from a number of regional and national populations. For average consumption measured in dollars the linear model explains 66% of the variance and for normalized gambling consumption the linear model explains 80% of the variance. Although there is room for other factors to influence the percentage of heavy consumers, clearly the average consumption level of a population is a key estimator of the level of heavy gambling consumption in the Windsor sample. This finding provides significant support for the applicability of Ledermann's hypothesis to gambling consumption

Sub-Group Differences

Although the consumption data for the various sub-groups, e.g., males and females, is a good fit to the theoretical lognormal distribution, the distributions are by no means uniform across the various subgroups. Taking the male and female subgroups as an example and utilizing normalized consumption data to remove income effects, we find that the mean consumption level between males and females differs by a factor of approximately 1.5:1. Other subgroups, such as, income, religion, and age, have similar differences, with the greatest difference being found across the income subgroups. Considering that gambling availability in the City of Windsor is essentially the same for the various groups and that the consumption data have been normalized or corrected for income level, the differences are most likely due to cultural differences between the various groups. For example, members of a religious group may well have cultural norms that discourage excessive drinking or gambling that are derived from religious teachings and practices. Consumption differences between various cultural subgroups have also been observed for alcohol consumption. These cultural differences support Skog's contention that social factors play a significant role in determining the average consumption level of a population (Skog, 1985b). However, the Windsor data are based on a regional sample and other regional and national data will be required before the extent of cultural differences in gambling consumption can be fully determined.

Dose-Response Relationship

The strong relationship found between average consumption and the percentage of heavy consumers in the Windsor sample is only a concern if there is a relationship between consumption and gambling related problems. When the SOGS scores are used as an indication of the gambling related problems experienced by an individual and consumption is measured in terms of monetary expenditures on gambling, there is a modest dose-response relationship. Figures 21 and 24 show high levels of SOGS endorsements at relatively low levels of consumption and regression analysis and Tables 29 and 23 show explained variance of the curve fitting model of up to 20% for the gambling expressed as an annual expenditure and up to 28% for normalized gambling expenditures. Although the relationships are statistically and practically significant they leave ample room for other factors to contribute to levels of problem gambling as measured by the SOGS. This is somewhat surprising since the SOGS has been criticized for its emphasis on the financial aspects of gambling (Ferris et al., 1998). There are two possible explanations for the observed poor fit, the subjective, self-report nature of the SOGS (Stinchfield, 1998) and the use of a single dimension to measure gambling consumption. To illustrate the first possible explanation let us assume two gamblers, A and B, who endorse the SOGS item indicating that they have gambled more than they intended to in the last year. Let us also assume that we are able to carry out an interview after these two gamblers have completed their SOGS questionnaire. In interviewing gambler A we find that he or she is a frequent gambler, gambling at least once a week, and that approximately 50% of the time over the last year his/her gambling has greatly exceeded the "gambling limit" of $500. We find that Gambler A having accumulated debts of over $20,000 is experiencing considerable financial distress. Probing further in the interview we might well find that gambler A has had his/her gambling criticized, has had numerous arguments over gambling, has chased losses, has tried to quit but been unsuccessful, borrowed from a number of sources, and feels guilty about his/her gambling. If gambler A had completed the SOGS accurately, his/her score would be well over the five required to classify him/her as a pathological gambler, a classification that would be supported by the clinical interview. On interviewing gambler B we find that she/he gambles once a month and usually stays within his/her $50 limit. However four months ago gambler B "got carried away" and lost $300. Probing further in the interview, we find that gambler B's family was quite upset, his gambling was strongly criticized for several weeks, gambler B had several arguments with his/her spouse over gambling and still feels guilty over this overspending. If gambler B completes the SOGS in a manner that is consistent with his/her subjective feelings, gambler B would have a SOGS score of at least four and be classified by the screen as a problem gambler, a classification that would not be supported by the clinical interview. Such subjective self-reporting may explain, at least in part, the high number of gambling related problems endorsed by gamblers at low consumption levels. Stinchfields's findings that the SOGS has a high false positive rate (50%) supports this hypothesis.

The other possible explanation for the poor fit between SOGS scores and consumption level is the exclusive use of dollar expenditures as a measure of gambling consumption. Although experienced clinicians find that at least 90% of adult gamblers come into treatment because of financial difficulties and that most of the problems gamblers in treatment experience, e.g., relationship problems, stem from their financial difficulties (Personal Communication, Roger Horbey, Nov. 1999) caution should be exercised in generalizing from a clinical population to the general population. One can well imagine gambling related problems based on time rather than expenditures, for example, an individual who spends four, six or more hours at bingo almost every day. By limiting the number of cards played, the gambler may keep the financial impact manageable, but may experience significant relational, vocational and even health problems because of the time spent on gambling. It is interesting to note that one of the few major population studies of alcohol consumption over time that failed to find a significant relationship between a longitudinal increase in alcohol consumption and the percentage of heavy consumers was the Iowa study [Fitzgerald, 1981 #386]. The Iowa study utilized a quantity-frequency index rather than alcohol consumption alone. The current Windsor data base did not capture the amount of time spent on gambling and does not allow the exploration of this or other alternate measure of gambling consumption to be explored. Further research will be required to resolve this issue.

The use of a risk measure as an alternate to the dose-response relationship removes some of the problems associated with the subjective, self-report nature of the SOGS. Although the relative change in the risk of becoming a problem or pathological gambler provides a reasonable reflection of the change in risk with increased consumption, the absolute values of the risk estimated by the SOGS scores may well be inflated because of the high level of false positives the screen produces (Stinchfield, 1998). For gambling consumption measured both in annual expenditures and in percentage of annual income spent on gambling, the increase in risk of being a pathological gambler increases as a power function of the consumption level, although the exponent is close to one. This finding is consistent with the increasing rate of risk found in alcohol related problems (Bruun et al., 1975; Edwards et al., 1994). The risk of problem gambling increases rapidly at low levels of consumption and slowly at high levels of consumption (Figures 21 and 26). This finding is consistent with the finding that there is a modest relationship between the level of gambling consumption and the number of SOGS items endorsed. With this relationship we would expect more gamblers at the high consumption levels to have a sufficient number of gambling related problems to qualify for the classification of pathological gambling rather than problem gambling.

The Prevention Paradox

The distribution of gambling related problems in a population is of practical as well as theoretical interest and can be used to guide the design of prevention programs. The data in Table 27 demonstrates reasonably comparable rates at various consumption levels. Although the rates of gambling related problems experienced by the low consuming segments of the Windsor sample are small in total, the number of gamblers in these segments result in a total number of problems that are comparable to the less populated higher consuming segments of the sample. These findings are similar to findings reported for alcohol related problems in populations (Cartwright et al., 1978a; Rose, 1981). However, the data must be approached with some caution. It is not clear if the severity of the reported problems is the same at different consumption levels. Intuitively one would expect problem severity to increase with consumption. Unfortunately the SOGS does not collect any information that would indicate the severity of the various problem behaviours. Also, the subjective self-report nature of the SOGS and the high false positive rate suggest that the SOGS items are over reported in the general population (Stinchfield, 1998) and such over reporting may well distort the distribution of gambling related problems across consumption levels. Despite the data limitations, the results strongly suggest that the gambling related problems are found in reasonably comparable levels across the various levels of gambling consumption.

Summary

In summary, the present study utilizing the Windsor survey data has provided strong support for the applicability of the distribution of consumption model to gambling behaviour. The distributions are clearly lognormal, there is a good relationship between average consumption and the percentage of heavy consumers, there is an increasing risk of becoming a problem or pathological gambler with increased gambling consumption and there are significant sub-population differences in consumption that can be attributed to cultural differences.

Significance and Implications of the Findings

One of the most striking aspects of the results obtained in this study is the strong parallel between gambling consumption and alcohol consumption. This suggests that the underlying population dynamics of gambling and alcohol use are very similar. This finding questions the separate DSM-IV classification for gambling and substance abuse, and suggests that continued efforts should be made to develop models such as the General Addictions model (Jacobs, 1986) that views addictions as a unitary phenomenon. The parallel also suggest that the rich and extensive alcohol literature has considerable applicability to gambling behaviour. The results of the present study suggest that the pace of research in gambling could be accelerated by a greater utilization of alcohol research. The parallels also raise questions about the value of separating gambling from other addictive behaviours in the DSM-IV.

The lognormality of a distribution provides insight into the population dynamics. As Skog (1985) has noted, lognormality of a population parameter implies that the factors that contribute to that parameter in the population combine multiplicatively rather than additively as they do for a normally distributed parameter. It is the multiplicative combination of a number of risk factors in a small number of individuals that create the highly skewed distribution of gambling consumption. Thus the presence of a lognormal distribution for gambling consumption suggests that reductions in the number or magnitude of risk factors, for individuals or for the population as a whole, have the potential of producing a significant reduction in gambling related problems.

The variability of average consumption across the various population subgroups, despite equal availability, implies that some of the risk factors are socio-cultural in nature. The income subgroups can provide an illustration of how socio-cultural differences among subgroups can create different levels of gambling consumption. The Windsor survey data shows that lower income groups spend a significantly higher percentage of their income on gambling. A recent study by the Consumer Foundation of America found that lower income families in the USA (≤$35,000) tended to have significant distortions about wealth creation (Consumer Foundation of America, 1999). This group underestimated their ability to accumulate wealth by savings and

40% thought that they were more likely to accumulate $500,000 in a lottery than by savings. The high prevalence of such cognitive distortions about wealth creation and the likelihood of winning a lottery coupled with the inevitable financial pressures of low income earners can be significant cultural risk factors for the low income subgroups. Knowledge of these socio-cultural risk factors can be used to develop prevention programs aimed at correcting this and other distortions. Indeed without such socio-culturally specific knowledge it would be difficult to design an effective prevention program for this subgroup.

A general conclusion that can be drawn from the results of the present study is that it is important and meaningful to examine the distributions of data that are encountered in epidemiological studies. The nature of the distributions can provide valuable information on the population dynamics. This understanding enhances the theoretical understanding of the behaviour under study and can provide suggestions as to the management of that behaviour in the populations under study.

Although the distribution of consumption model provides insight into the basic population dynamics described above and strongly suggests that risk factors should be reduced, the model is typical of basic theories in that it does not provide obvious guidance as to how to go about applying this basic knowledge. A bridging model is required to help in the practical application of the basic theoretical model. The diffusion of innovation model provides a means of understanding how basic social and economic forces shape social behaviours and provides insight as to how prevention policies can be developed to influence social behaviours. The diffusion of innovation model describes the mechanisms by which an idea, a behaviour or a product is spread throughout a population. The model has also been applied to substance use (Ferrence, 1994, 1996). Although initially the diffusion of innovation model was seen as a process of social imitation progressing from higher to lower social classes (Tarde, 1903) subsequent development has broadened the model to include social and economic processes (Davis, 1985, as cited in Ferrence, 1994: Rogers & Shoemaker, 1983). Three broad social processes are considered to underlie the diffusion of innovation: rational/economic processes, behavioural processes, and systems processes. Rational and economic processes include items such as production and distribution, corporate resources, the ability to promote a product and the cost benefits of the distribution or purchase of the product. Behavioural processes center around communication mechanisms, either interpersonal or through the media. Systems processes include marketing by which population sub-groups are targeted and broad structural processes such as government taxation and policy.

Collectively the elements of the diffusion of innovation model move the perspective on addictive behaviours from a focus on individual factors, e.g., genetic or psychological, to a broad economic and marketing perspective. This broad perspective provides a basis for the development of research programs and public policy for problem gambling prevention. Research programs should be developed to determine the relative importance of the various diffusion processes in shaping gambling and problem gambling behaviour while policy makers should utilize the outcome of such research and employ a broad range of social and economic processes to prevent gambling related problems.

Limitations of the Study

The Windsor survey data, like most survey data, have a number of limitations that stem from the survey process and the nature of the instruments used. Although the response rates for the surveys were comparable or better than similar studies, a significant proportion of the population, approximately 25%, declined to respond. Despite this level of non-response, the data, when compared to census data, are a reasonable but not completely accurate representation of the Windsor population. Data, such as the estimated annual gambling expenditures, depend on the participant's subjective and fallible memory and can be expected to have some distortions from the actual. The SOGS has been shown to over report the number of problem and pathological gamblers in a population when compared to DSM-IV criteria (Stinchfield, 1998) suggesting that similar distortions are likely present in the Windsor survey data. The Windsor survey data were considered suitable for testing the various elements of the distribution of consumption model because the tests depend on the relative frequencies of data and the relationship between variables rather than the absolute values of the data.

In addition to data limitations, a significant limitation stems from the fact that the data represent only a small geographic region and its sub-populations. A full test of the distribution of consumption Model will require a demonstration of its applicability in a number of regional and national populations.

Future Research

The present study suggests two broad areas of research, the further testing and development of the distribution of consumption model for gambling and the identification of gambling risk factors. As noted previously, a full test of the model will require a demonstration of its applicability in a number of distinct populations. The simplest approach is for researchers with existing survey data to test the applicability of the model to their survey data. If support is found for the distribution of consumption model, surveys specifically designed to collect data to test the model would be justified. The multiplicative nature of the risk factors also suggests that further research into gambling risk factors would be of considerable value. The diffusion of innovation model discussed earlier provides a structure around which the social processes that shape gambling and problem gambling behaviour can be studied. Such research would provide information of considerable use in the development of prevention and treatment programs.

Appendix A

Mathcad Work-Sheet

Fitting lognormal fn to estimated consumption data

Program name = Test I

$ORIGIN \equiv 1$ **Reset the origin point for vectors to 1 from 0**

$l :=$ A:\Test1.txt **Read in ASCII data - assumed sorted in assending order**

$p :=$ A:\Test1.txt **Create vector of same length as data**

$n := \mathrm{length}(l)$

$n = 1.381 \cdot 10^{3}$

$i := 1, 2 .. n$

$p_i := \frac{i - .5}{n}$ **Calculate cumulativie probability using the Rankit method**

$\mathrm{Error}(\alpha, \beta) := \sum_{i} \left| \mathrm{plnorm}\left(l_i, \alpha, \beta\right) - p_i \right|$ **Error function based on the linear distance between theoretical and actual**

Solve block begins here

$\alpha := -1 \qquad \beta := 2$ **Initial estimates for mean and standard deviation**

Given

$1 = 1$

$\mathrm{Error}(\alpha, \beta) = 0$

$$\mathrm{Error}(\alpha,\beta) := \sum_i \left| \mathrm{plnorm}\left(l_i,\alpha,\beta\right) - p_i \right| \cdot \left| \mathrm{plnorm}\left(l_i,\alpha,\beta\right) - p_i \right|$$

Error function based on the square of the diferences

$\alpha := -1$ $\beta := 2$ **Initial estimates for mean and standard deviation**

Solve block begins here

Given

$\mathrm{Error}(\alpha,\beta) = 0$

$l = 1$

$$\begin{bmatrix} \alpha \\ \beta \end{bmatrix} := \mathrm{Minerr}(\alpha,\beta)$$

$\alpha = -1.1586$ **Estimated mean and standard deviations**

$\beta = 1.6759$

$$\frac{\mathrm{Error}(\alpha,\beta)}{n} = 7.4644 \cdot 10^{-5}$$ ***Average error***

$$\begin{bmatrix} \alpha \\ \beta \end{bmatrix} := \mathrm{Minerr}(\alpha, \beta)$$

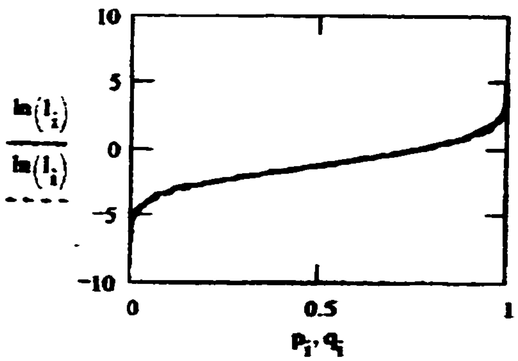
$\alpha = -1.1611$ **Estimated mean and standard deviations**

$\beta = 1.6798$

$$\frac{\mathrm{Error}(\alpha, \beta)}{n} = 6.8173 \cdot 10^{-3}$$ **Average error**

Calculated cum prob

$$q_i := \mathrm{plnorm}\left(l_i, \alpha, \beta\right)$$



Comparison of estimated and actual data

Appendix B

The South Oaks Gambling Screen

SOUTH OAKS GAMBLING SCREEN

Name ______________________________ Date ______________

1. Please indicate which of the following types of gambling you have done in your lifetime. For each type, mark one answer: "not at all," "less than once a week," or "once a week or more."

	not at all	less than once a week	once a week or more	
a.	____	____	____	play cards for money
b.	____	____	____	bet on horses, dogs or other animals (at OTB, the track or with a bookie)
c.	____	____	____	bet on sports (parlay cards, with a bookie, or at Jai Alai)
d.	____	____	____	played dice games (including craps, over and under or other dice games) for money
e.	____	____	____	gambled in a casino (legal or otherwise)
f.	____	____	____	played the numbers or bet on lotteries
g.	____	____	____	played bingo for money
h.	____	____	____	played the stock, options and/or commodities market
i.	____	____	____	played slot machines, poker machines or other gambling machines
j.	____	____	____	bowled, shot pool, played golf or some other game of skill for money
k.	____	____	____	pull tabs or "paper" games other than lotteries
m.	____	____	____	some form of gambling not listed above (please specify) ______________

2. What is the largest amount of money you have ever gambled with on any one day?

___ never have gambled
___ $1 or less
___ more than $1 up to $10
___ more than $10 up to $100
___ more than $100 up to $1,000
___ more than $1,000 up to $10,000
___ more than $10,000

3. Check which of the following people in your life has (or had) a gambling problem.

___ father ___ mother ___ a brother or sister ___ a grandparent

___ my spouse or partner ___ my child(ren) ___ another relative

___ a friend or someone else important in my life

4. When you gamble, how often do you go back another day to win back money you lost?

___ never
___ some of the time (less than half the time I lost)
___ most of the time I lost
___ every time I lost

SOUTH OAKS GAMBLING SCREEN

5. Have you ever claimed to be winning money gambling but weren't really? In fact, you lost?
   ___ never (or never gamble)
   ___ yes, less than half the time I lost
   ___ yes, most of the time

6. Do you feel you have ever had a problem with betting money or gambling?
   ___ no
   ___ yes, in the past but not now
   ___ yes

7. Did you ever gamble more than you intend to? . . . . ___ yes ___ no

8. Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true? . . . . ___ yes ___ no

9. Have you ever felt guilty about the way you gamble or what happens when you gamble?. . . . . ___ yes ___ no

10. Have you ever felt like you would like to stop betting money or gambling but didn't think you could? . . . . ___ yes ___ no

11. Have you ever hidden betting slips, lottery tickets, gambling money, I.O.U.s or other signs of betting or gambling from your spouse, children or other important people in your life? . . . . ___ yes ___ no

12. Have you ever argued with people you live with over how you handle money? . . . . ___ yes ___ no

13. (If you answered yes to question 12):Have money arguments ever centered on your gambling? . . . . . . ___ yes ___ no

14. Have you ever borrowed from someone and not paid them back as a result of your gambling?. . . . . ___ yes ___ no

15. Have you ever lost time from work (or school) due to betting money or gambling? . . . . ___ yes ___ no

16. If you borrowed money to gamble or to pay gambling debts, who or where did you borrow from? (check "yes" or "no" for each)

	no	yes
a. from household money ____________	( )	( )
b. from your spouse ____________	( )	( )
c. from other relatives or in-laws ____________	( )	( )
d. from banks, loan companies or credit unions ____	( )	( )
e. from credit cards ____________	( )	( )
f. from loan sharks ____________	( )	( )
g. you cashed in stocks, bonds or other securities __	( )	( )
h. you sold personal or family property ________	( )	( )
i. you borrowed on your checking account (passed bad checks) ____________	( )	( )
j. you have (had) a credit line with a bookie ______	( )	( )
k. you have (had) a credit line with a casino ______	( )	( )

SOUTH OAKS GAMBLING SCREEN SCORE SHEET

Scores on the SOGS itself are determined by adding up the number of questions which show an "at risk" response:

Questions 1, 2 & 3 not counted:

____ Question 4 -- most of the time I lose
or
every time I lose

____ Question 5 — yes, less than half the time I lose
or
yes, most of the time

____ Question 6 — yes, in the past but not now
yes

____ Question 7 — yes
____ " 8 — yes
____ " 9 — yes
____ " 10 — yes
____ " 11 — yes
" 12 not counted
____ " 13 — yes
____ " 14 — yes
____ " 15 — yes
____ " 16a — yes
____ " b — yes
____ " c — yes
____ " d — yes
____ " e — yes
____ " f — yes
____ " g — yes
____ " h — yes
____ " i — yes
questions 16j & k not counted

Total =_____ (there are 20 questions which are counted)

0 = no problem

1-4 = some problem

5 or more = probable pathological gambler

Appendix C

Problem Gambling Prevalence Survey

1	Do you approve or disapprove of the casino to be opened soon?	1
	Approve....................1 Disapprove.................2 Don't know.................3 Refusal....................4	☐

2	After the casino is opened do you believe that gambling will increase stay the same or go down.	2
	Increase...................1 Decrease...................2 Stay the same..............3 Don't know.................4 Refused....................5	☐

3	After the casino is opened do you think that the amount of gambling that you do will increase, stay the same or decrease?	3
	Increase...................1 Decrease...................2 Stay the same..............3 Don't know.................4 Refused....................5	☐

4	Do you think the new casino will be a benefit to the City of Windsor or not?	4
	Benefit....................1 Not a benefit..............2 No difference..............3 Don't know.................4 Refused....................5	☐

Now I would like to ask you some questions on your experiences with gambling.

5	People bet money on many different things, including bingo games, lotteries, the outcome of sports events, and card games. Have you ever bet money on these kinds of games or on anything else?	5
	Yes..................1 No...................2 Don't know...........3 Refused..............4 For anything other than Yes go to demographic section - Page 20.	☐

6	Please tell me which of the following types of gambling you have done in your lifetime. For each type that I read out there are three possible answers " not at all", "less than once a week", and "once a week or more", please chose one. Have you ever played bingo for money	6
	Not at all................1 **Less than once a week**.....2 **Once a week or more**.......3 **Refused**..................4	☐

7 Have you played bingo for money in the last year?	7
Not at all................1 **Less than once a week**.....2 **Once a week or more**.......3 **Refused**...................4	☐

8 How much would you have spent playing bingo in the last month.	8
☐☐,☐☐☐ -1 = Refusal	

9 Have you ever played pull tabs or break open tickets?	9
Not at all................1 **Less than once a week**.....2 **Once a week or more**.......3 **Refused**...................4	☐

10 Have you played pull tabs or break-open tickets in the last year?	10
Not at all................1 **Less than once a week**.....2 **Once a week or more**.......3 **Refused**...................4	☐

11 About how much have you spent playing pull tabs or break-open tickets in the last month?	11
□□,□□□ -1 = Refusal	

12 Have you ever bet money at a racetrack?	12
Not at all................1 **Less than once a week**.....2 **Once a week or more**.......3 **Refused**..................4	□

13 Have you bet money at a racetrack in the last year?	13
Not at all................1 **Less than once a week**.....2 **Once a week or more**.......3 **Refused**..................4	□

14	About how much would you have bet in the last month at the racetrack?	14
	□□,□□□ -1 = Refusal	

15	Have you ever bought lottery tickets.	15
	Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	□

16	Have you bought lottery tickets in the last year.	16
	Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	□

17	About how much would you say you have spent on lottery tickets in the last month.	17
	□□,□□□ -1 = Refusal	

18	Have you ever bet with a bookmaker on the outcome of a sporting event?	18
	Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

19	Have you bet with a bookmaker on the outcome of a sporting event in the last year?	19
	Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

20	About how much would you say you have spent betting with a bookmaker on sporting events in the last month.	20
	☐☐,☐☐☐ -1 = Refusal	

21 Have you ever played the sport select game.	21
Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

22 Have you played the sport select game in the last year?	22
Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

23 About how much would you have spent on the sport select game in the last month?	23
☐☐,☐☐☐ -1 = Refusal	

24 Have you ever played any video lottery games?	24
Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

25 Have you played a video lottery game in the last year?	25
Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

26 About how much would you spend in a month on video lottery games?	26
☐☐,☐☐☐ -1 = Refusal	

27 Have you ever played casino games such as blackjack?	27
Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

28 Have you played such casino games in the last year?	28
Not at all................1 Less than once a week.....2 Once a week or more.......3 Refused...................4	☐

29 About how much would you have spent on casino games in the last month?	29
☐☐,☐☐☐ -1 = Refusal	

30 Have you ever left Ontario to gamble?	30
Yes...........1 No............2 Refused.......3	☐

31 Have you left Ontario to gamble in the last year?	31
Yes...........1 No............2 Refused.......3	☐

32 About how much would you have spent on gambling on one of these trips?	32
☐☐,☐☐☐ -1 = Refusal	

33 When you go outside the provence to gamble where do you usually go?	33
______________________	☐

33A	33A
Categories to be filled out later	☐

34 How often would you go outside of the provence to gamble in a year?	34
______________ 1-99	☐ ☐

35 What is the largest amount of money you have ever gambled with on any one day?	35
☐☐,☐☐☐ -1 = Refusal	

36	Which of the following people in your life has (or has had) a gambling problem?	36
	Father..............................**1** **Mother**..............................**2** **A brother or sister**..................**3** **A grandparent**........................**4** **My spouse or partner**.................**5** **My child**............................**6** **Another relative**.....................**7** **A friend or someone else important in your life**........................**8** Refused..............................9	☐

37	When you gamble how often do you go back another day to win back money you lost?	37
	Never.......................**1** **Some of the time (less than half the time you lost)**....................**2** **Most of the time you lost**.....**3** **Every time you lost**..........**4** **Refusal**.....................**5**	☐

38 *If yes to above question* Have you gone back to win back money you have lost in the last year?	38
Never........................1 **Some of the time (less than half the time you lost)....................2** **Most of the time you lost.....3** **Every time you lost..........4** **Refusal......................5**	☐

39 Have you ever claimed to be winning money gambling but were not really? In fact you lost.	39
Never ....1 **Yes, less than half the time.......2** **Yes, most of the time..............3** **Refused..........................4**	☐

40 *If yes to above question* Have you made such claims in the last year?	40
Never ....1 Yes, less than half the time.......2 Yes, most of the time..............3 Refused..........................4	☐

41 Do you feel you ever had a problem with betting money or gambling?	41
No..............................1 **Yes, in the past, but not now.....2** **Yes ....3** **Refused..........................4**	☐

41I If answer to above is yes (2 or 3) Do you feel you have had a problem with betting money or gambling in the last year?	41I
No....................1 Yes...................2 Refused...............3	☐

42 Did you ever gamble more than you intended to?	42
Yes...............1 No................2 Refused...........3	☐

43	Did you gamble more than you intended to in the last year?	43
	Yes................1 No.................2 Refused............3	☐

44	Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you though it was true?	44
	Yes................1 No.................2 Refused............3	☐

45	Have you received such criticism in the last year?	45
	Yes................1 No.................2 Refused............3	☐

46	Have you ever felt guilty about the way you gamble or what happens when you gamble?	46
	Yes................1 No.................2 Refused............3	☐

47 Have you felt guilty about the way you gamble or what happens when you gamble in the last year?	47
Yes................1 No.................2 Refused............3	☐

48 Have you ever felt like you would like to stop betting money or gambling but didn't think you could?	48
Yes...........1 No............2 Refused.......3	☐

49 *If yes to above question* Have you felt like you would like to stop betting money or gambling but didn't think you could in the last year?	49
Yes...................1 No....................2 Refused...............3	☐

50 Have you ever hidden betting slips, lottery tickets, gambling money, I. O. U.s or other signs of betting or gambling from your spouse, children, or other important people in your life?	50
Yes...........1 No............2 Refused.......3	☐

51 *If yes to above question* Have you hidden such things in the last year?	52
Yes....................1 No.....................2 Refused................3	☐

52 Have you ever argued with people you live with over how you handle money?	52
Yes...........1 No............2 Refused.......3	☐

53 Have money arguments ever centred on your gambling?	53
Yes...........1 No............2 Refused.......3	☐

54 *If yes to above question* Have you had such gambling related arguments in the last year?	54
Yes...................1 No....................2 Refused...............3	☐

55 Have you ever borrowed from someone and not paid them back as a result of your gambling?	55
Yes...................1 No....................2 Refused...............3	☐

56 Have you borrowed from someone and not paid them back in the last year?	56
Yes....................1 No.....................2 Refused................3	☐

57 Have you ever lost time from work (or school) due to gambling?	57
Yes...........1 No............2 Refused.......3	☐

58 *If yes to above question* Have you lost time due to gambling in the last year?	58
Yes...................1 No....................2 Refused...............3	☐

59	Have you ever borrowed money to gamble or pay gambling debts?	59
	Yes...........1 No............2 Refused.......3	☐

	If yes to the previous question Which of the following areas did you borrow from?	
60	From household money Yes...........1 No............2 Refusal.......3	60 ☐
61	From your spouse Yes...........1 No............2 Refusal.......3	61 ☐
62	From other relatives or in-laws Yes...........1 No............2 Refusal.......3	62 ☐
63	From banks, loan companies, or credit unions Yes...........1 No............2 Refusal.......3	63 ☐

64	From credit cards Yes...........1 No............2 Refusal.......3	64 ☐
65	From loan sharks Yes...........1 No............2 Refusal.......3	65 ☐
66	From stocks, bonds, or other securities you cashed in Yes...........1 No............2 Refusal.......3	66 ☐
67	From the sale of personal or family property Yes...........1 No............2 Refusal.......3	67 ☐
68	By borrowing on your checking account (passing bad checks) Yes...........1 No............2 Refusal.......3	68 ☐
69	By having a credit line with a bookie Yes...........1 No............2 Refusal.......3	69 ☐
70	By having a credit line with a casino Yes...........1 No............2 Refusal.......3	70 ☐

71 *If yes to above block of questions* Have you borrowed money to gamble or pay gambling debts in the last year?	71
Yes...........1 No............2 Refused.......3	☐

If yes to the previous question Which of the following areas did you borrow from in the last year?	
72 From household money Yes...........1 No............2 Refusal.......3	72 ☐
73 From your spouse Yes...........1 No............2 Refusal.......3	73 ☐
74 From other relatives or in-laws Yes...........1 No............2 Refusal.......3	74 ☐

75	From banks, loan companies, or credit unions Yes...........1 No............2 Refusal.......3	75 ☐
76	From credit cards Yes...........1 No............2 Refusal.......3	76 ☐
77	From loan sharks Yes...........1 No............2 Refusal.......3	77 ☐
78	From stocks, bonds, or other securities you cashed in Yes...........1 No............2 Refusal.......3	78 ☐
79	From the sale of personal or family property Yes...........1 No............2 Refusal.......3	79 ☐
80	By borrowing on your checking account (passing bad checks) Yes...........1 No............2 Refusal.......3	80 ☐
81	By having a credit line with a bookie Yes...........1 No............2 Refusal.......3	81 ☐

82	By having a credit line with a casino Yes...........1 No............2 Refusal.......3	82 ☐

83	How much would you say you have bet on gambling in the last year? Your best guess is fine.	83
	☐☐,☐☐☐ -1 = Refusal *Read as a guide if necessary* and enter values as shown $0...........................0 >$0 and up to $10...............5 >10 and up to $50..............30 >$50 and up to $100............75 >$100 and up to $500..........300 >$500 and up to $1,000........750 >$1,000 and up to $5,000.....3000 >$5,000 and up to $10,000....7500 >$10,000 and up.............10000	☐

84	How much would you say you have won or lost in the last year while gambling? Your best guess is fine.	84

84A Won □□,□□□

-1 = Refusal

84B Lost □□,□□□

-1 = Refusal

Read as a guide if necessary and enter values as shown

$0..............................0
>$0 and up to $10...............5
>10 and up to $50..............30
>$50 and up to $100............75
>$100 and up to $500..........300
>$500 and up to $1,000........750
>$1,000 and up to $5,000.....3000
>$5,000 and up to $10,000....7500
>$10,000 and up.............10000

Now I would like to ask you some questions about yourself 85 What is your exact age.	85
☐☐ -1 = Refusal If hesitant to give age offer to read ranges below and enter value shown 18 - 30 years....24 31 - 45 years....38 46 - 60 years....53 Mark if ranges used 61 - 74 years....68 74 - and over....80 ☐	

86 How long have you lived in the Windsor area? Your best guess is fine.	86
Express answer in years and part years ☐☐.☐ -1 = Refusal	

87 What is your present marital status?	87
Married................1 Widowed................2 Separated..............3 Divorced...............4 Single (never married)..5 Common law.............6 Refused................7	☐

88 Are you currently working for pay? *If not go to 91*	88
Yes..................1 No...................2 Refused..............3	☐

89 What is your job	89
______________________________ Professional administrator or executive...........1 Clerical work, administrative support, sales or technicians......................................2 Crafts, trades, factory work, service or labour...3 Refused..4	☐

90 Which of the following income ranges best describes your annual personal income, before taxes? Go to 92	90
Less than $20,000.............1 **$20,000 to $29,999...........2** **$30,000 to $39,999...........3** **$40,000 to $49,999...........4** **$50,000 to $59,999...........5** **$60,000 to $69,999...........6** **$70,000 to $79,999...........7** **$80,000 to $99,999...........8** **$100,000 or more.............9** Read to this point Not sure.....................10 Refused......................11	☐ ☐

91 Which of the following best describes you?	91
A homemaker..................1 **Retired or disabled..........2** **A student....................3** **Not currently employed.......4** ____________________ **Refused......................5**	☐

92 Which of the following ranges best describes your total household income, before taxes. Your best guess is OK.	92
Less than $20,000.............1 **$20,000 to $29,999...........2** **$30,000 to $39,999...........3** **$40,000 to $49,999...........4** **$50,000 to $59,999...........5** **$60,000 to $69,999...........6** **$70,000 to $79,999...........7** **$80,000 to $99,999...........8** **$100,000 or more.............9** -- Read to this point -- Not sure.....................10 Refused......................11	☐ ☐

93 Are you a member of a church or religious group?	93
Yes..................1 No...................2 Refused..............3	☐

94 *If Yes to above question* Which church or religious group?	94
Catholic.....................1 Greek or Russian Orthodox....2 Protestant...................3 Jewish.......................4 Moslem.......................5 Buddhist.....................6 Hindu........................7 Other (write in space below).8 ____________________ Refused......................9	☐

95	What is the highest grade or year of schooling you have completed?	95
	No schooling..................1 First to 7th grade............2 8th grade.....................3 Some high school..............4 High school graduate..........5 Some community college........6 Community college graduate....7 Some university...............8 University graduate...........9 Graduate degree..............10 Refused......................11	

96	Since the telephone often distorts voices I sometimes have difficulties in determining the sex of the person I am talking to, would you please tell me your sex.	96
	Female...............1 Male.................2 Refused..............3	

97	What are the first three letters and numbers of your postal code	97
	☐☐☐ -1 = Refusal	______

98	If someone you knew had a gambling problem where would you suggest that they go for treatment?	
	____________________________________	☐

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VITA AUCTORIS

Richard Govoni was born in Hamilton, Ontario in 1945. He completed a BSc in physics at the University of Toronto in 1969, and returned to the University of Toronto to complete the specialist program in psychology in 1993. He entered the Ph.D. program in adult clinical psychology at the University of Windsor in 1993-1994 and earned his MA in 1995. During his stay at the University of Windsor he initiated and managed three major gambling prevalence studies, was one of the founders of the Problem Gambling Research Group (PGRG), and developed and is currently managing two major research initiatives for the PGRG. He has been the Associate Director of the PGRG since its inception in 1993.